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ABSTRACT

Technology enriched school projects are initiatives in real school settings that try to reduce or remove problems and constraints that hamper the effective use of computers in the schools. These projects are based, not on technology, but on educational need and vision. They examine the atmosphere and functioning of a school that uses technology for change and stimulation. The following case studies from technology enriched schools are presented: (1) "Mount Newton: A Technology-Enriched Middle School" (Keven Elder); (2) "California Model Technology Schools: The Monterey Perspective" (Kam Matray); (3) "Apple Classroom of Tomorrow: West High School" (Robert Howard and Jane Pratt); (4) "Technology-Enriched Schools in the Netherlands" (Jef Moonen and Jos Beishuizen); (5) "An Information Technology School Project in Romania" (Ion Diamandi); (6) "Computerization of an Israeli School System: Project Comptown" (Elad Peled, Zimra Peled, and Gad Alexander), (7) "School of the Future Project at F. M. Black Middle School" (Richard A. Smith and Anthony Sassi); (8) "The Quinte Lighthouse Project" (Robert Holt); and (9) "Netherhall School: Building for the Future on the Experience of the Past" (Alastair J. Wells). Synthesis and reflections are provided by the editors in "Summarizing the Case Studies of Technology-Enriched Schools" and "Reflections on Technology-Enriched Schools." Five appendixes summarize details about the projects. (Contains 33 references.) (SLD)

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TECHNOLOGY ENRICHED SCHOOLS

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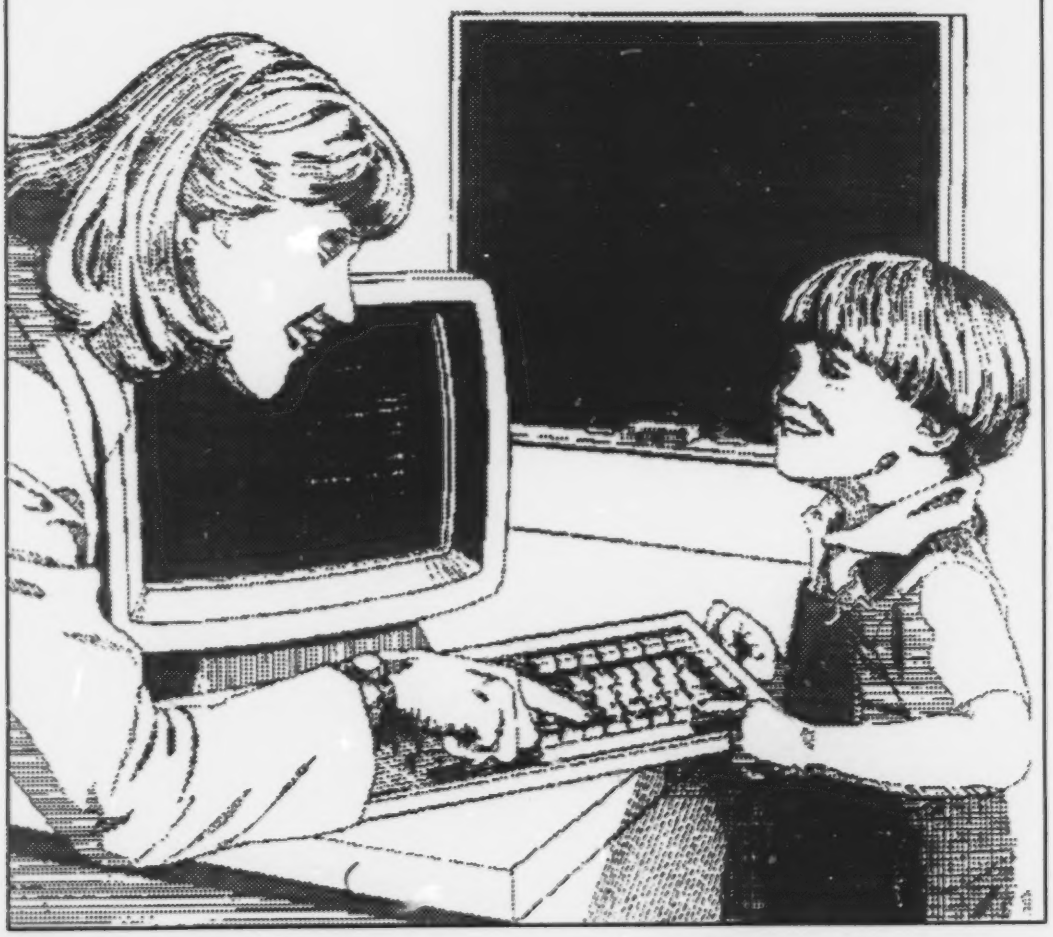

NINE CASE STUDIES WITH REFLECTIONS

EDITED BY BETTY COLLIS AND GERRIT CARLEER

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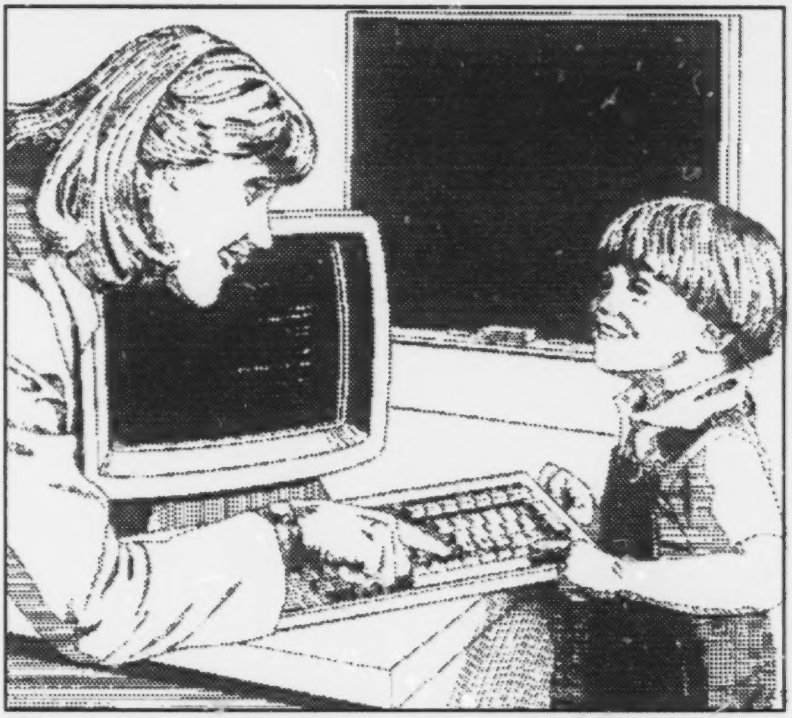

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In this section we give a brief overview of this book. We begin with a definition of "technology-enriched school" (TES) projects and then give an introduction to the nine case studies of technology-enriched school projects in this book. The importance—and the difficulty—of comparing the experiences of various TES initiatives and of seei..g how those experiences transfer to other schools and TES projects is also described in the introductory chapter.

Technology-Enriched Schools: Cases and Issues

by Betty Collis and Gerrit Carleer

1. What are Technology-Enriched School Projects? Why Should We Study Them?

1.1 Reaching for the potential of computers in education

We believe that computers can have a valuable impact in the school setting. We believe they can stimulate students, offer new instructional opportunities, revitalize teachers, and even contribute to restructuring whole school settings. Computer-related technology can bring new partnerships into the school—partnerships with industry, new relationships with the community, new types of collaborations with researchers, new resources from throughout the "global village" outside of the traditional classroom walls. We know that technology can be a catalyst to these possibilities.

But we also know that in most schools these possibilities are only beginning to be realized or not even happening. So many things keep the potential from developing as we think—or hope—it might. The list of problems and constraints is long:

> If only we had *more:*
> *time, money, equipment, technical support, support from the administration,*
>
> If only we had *better:*
> *ideas for instructional integration, opportunities for interaction with others, on-going support, information,*
>
> If only we had *different:*
> *ideas about curriculum, approaches to inservice, ways of forming partnerships with others outside the school,*
>
> Then just think what we could do!!!

1.2 Technology-enriched school projects

"Technology-Enriched School Projects" are initiatives in real school settings that try to reduce or remove as many of these problems and constraints as possible—to provide *more, and better, and different* environments so that, as much as possible, the current and future potential of computers in the school can be explored and enjoyed.

But, technology-enriched school projects are not based on technology. They are based on educational needs and vision. Instead of originating with technology, they focus on the uses of technology by teachers and students. They examine the atmosphere and functioning of a school that uses technology as a tool for change and stimulation. They are focused on the restructuring of education, with technology as a partner and tool.[1]

[1] See, for example, David, J. (1991, September). Restructuring and technology: Partners in change. *Phi Delta Kappan*, pp. 37-40, 78-82.

Technology-enriched school projects (or TES projects, for short) usually are multipartner, and these partnerships—involving business, the community, other schools and teachers, researchers, parents—are often innovations in themselves. Building on what we know about innovations in the school setting, TES projects are long-term, recognize the importance of the teacher, and work hard to involve teachers and administrators in the planning and decision making of the projects. TES projects generally involve the whole school, and recognize the complex interrelationships in the teaching and learning process.

And TES projects do involve new challenges with technology—not only because TES projects by definition involve extra infusions of computer-related technology relative to what is usually available to a school. An additional dimension of the technology-related challenge is that often this technology and the types of software running on it include new varieties of resources—multimedia, telecommunications, networks, scanners, interactive videodiscs—that teachers may not ever have used before.

1.3 Learning from technology-enriched schools

Thus TES projects offer tremendous opportunities to study both the potential and the problems that can develop in technology-enriched school environments. As more and more schools are becoming "technology-enriched" even without special projects, the value of learning from those settings that try to maximize the opportunities and minimize the problems is obvious.

But, we have difficulties learning from the experiences of current TES projects. A major reason is that we have difficulty finding out about them, or finding out enough to give us insights into our own situations. There are many TES projects going on throughout the world, but how can we find out about them? How can we learn from them?

"Learning from them" involves more than just getting some information. We need different ways of studying these projects than traditional educational experiments or surveys. We need better strategies for comparing different complicated settings as they respond in their own ways to different combinations and possibilities of new technologies in classrooms and schools. How can we better compare the:

- Goals of different TES projects?
- Motivations that inspire the different partners in TES projects?
- Strategies for support and stimulation of teachers in TES settings?

- Types of technology present and how this technology gets integrated into instruction?
- Reactions and impacts on the students in TES settings?
- Changes in the classroom, the school, even the community in TES settings?

How can we move from intuition and belief ("Think of what we might be able to do if we only had...*more, better, different*....) to know-how and insight?

One way is to systematically collect a wide range of information from a number of TES projects that appear to be running successfully. If we collect good information from different case studies of technology-enriched schools we may be able to apply a kind of "backward mapping"[2] to look for trends and combinations of factors that may have made an especially important contribution to the evolution of the project. This "multiple case study" approach is the strategy for this book.

2. About This Book

2.1 Beginnings at NECC '90

This book began following a preconference workshop at the National Educational Computing Conference (NECC '90) in Nashville, Tennessee. At this workshop we invited project leaders from various technology-enriched school initiatives to describe their projects and schools and to participate in a simulation of the setting-up of a new TES project in a hypothetical school.

The response to the workshop was lively and enthusiastic. The presenters did an excellent job of capturing important insights about their schools and projects; the participants in the workshop asked challenging questions; the different simulation groups came up with innovative approaches for the hypothetical TES project. At the end of the workshop there was a clear message—this sort of exchange of ideas and experiences should be available for others, not only others involved in TES projects, but everyone interested in improving the potential of technology in school environments. Thus this book was born.

An especially valuable aspect of the workshop was the contribution of persons from projects in a number of different countries. Becoming more aware of the different educational contexts and strategies in which TES settings occur gives us new ideas for our own environments. And the many similarities in problems and results, despite very different contexts and approaches, gives us stronger insights into what we can expect from technology infusion in the school.

[2] Fullan, M., Miles, M. E., & Anderson, S. E. (1988). *Strategies for implementing microcomputers in schools: The Ontario case*. Toronto: Ministry of Education.

2.2 Organization of the book

This book is thus organized as a set of nine case studies, each written by a person or persons in leadership positions in a technology-enriched school setting. The case studies describe 19 different schools in 6 countries. Of the 14 authors of the case studies, six were presenters at the NECC '90 workshop; the editors of this book were the organizers and chairpersons of that workshop. Table 1 gives an overview of the case studies in this book, the age of students involved, the locations of the schools. These case studies appear in Section 2 of the book.

3. Toward Synthesis and Recommendations

3.1. Organizing questions for the book

But this book is not only a collection of rich and interesting case studies. Synthesis, looking for trends and messages for other projects and schools, requires a methodology. Ours, the multiple case study approach with backward mapping, required us to impose a certain framework on the case study authors so that we would have similar categories of information from each of the cases for comparative purposes. Thus we asked our case study authors to organize their reports around five major headings:

- Background, context, and goals of the project
- Organization of the project
- Teacher involvement, training, and support
- What's happening now in the project?
- Results (to date) and recommendations

For each of these headings we asked the authors to make sure they gave us various types of information, so that we could address questions such as the following:

1. How did the "technology-enriched school" projects get started?
2. How do the goals of the projects compare?
3. How are technology-enriched projects organized from a point of view of personnel and time?
4. How is technology being integrated into instruction in technology-enriched schools?
5. What about technology-enriched schools from the perspective of the classroom teacher? What are strategies for teacher involvement, motivation, support, and training?
6. What results are emerging from technology-enriched school situations?

Table 1
Overview of the Cases

Authors	*Case*	*Number of Schools*	*Level*[1]	*Location*	*Number of Students*
Elder	Mt Newton	1	Grs. 6-8 (Ages 11-14)	Saanichton British Columbia	640
Matray	Monterey MTSS	4	2x Grs. k-5 (Ages 5-11) 1x Grs. 6-8 (11-14) 1x Grs. 9-12 (Ages 14-18)	Monterey, California	3162
Howard & Pratt	West	1	Grs. 9-12 (Ages 14-18)	Columbus, Ohio	120[2]
Moonen & Beishuizen	Dutch TES	3	Grs. 7-12 (Ages 12-18)	Netherlands	3700
Diamandi	School No. 56	1	Grs. 1-8 (Ages6-14)	Bucharest, Romania	2500
Peled, Peled & Alexander	Comptown	6	Grs. 1-8 (Ages 6-14)	Emory, Israel	2000
Smith & Sassi	F.M. Black	1	Grs. 6-8 (Ages 11-14)	Houston, Texas	1200
Holt	Quinte	1	Grs. 9-12 (Ages 14-18)	Belleville, Ontario	900
Wells	Netherhall	1	Grs. 7-12 (Ages 12-18)	Cambridge, United Kingdom	1400

Notes:
1. Expressed in equivalent U.S. grades
2. Participating in the TES project

7. What recommendations do persons involved in technology-enriched situations make to others moving into similar projects or situations?

3.2 Overview of Section 3

The case study authors did an excellent job in addressing these and many other questions in a limited number of pages. Because of the common format, our attempts at synthesis and trend-spotting were much facilitated. Section 3 of the book includes our synthesis of the nine case studies and the 19 technology-enriched schools described in these studies. In the first chapter in Section 3 we summarize the case studies around the seven questions listed above.

We conclude Section 3 with a short chapter highlighting our own reflections on the case studies, on technology-enriched schools—and on our methodology for studying technology-enriched school settings.

Section 2 consists of nine case studies. All of them involve technology-enriched schools that share some characteristics but are each unique in their own ways. The cases and some of their major characteristics are:

- Mount Newton Middle School
  (Saanichton, British Columbia, Canada)
  Teacher involvement in planning a new, technology-enriched school

- Monterey Model Technology Schools
  (Monterey, California)
  Teacher-developed "Classroom Intervention Plans," "SuperSubs," and strategies for dissemination of ideas

- West High School (Columbus, Ohio)
  An Apple Classroom of Tomorrow project with dramatic results in terms of transfer of student skills into the community

- The Dutch Technology Enriched School Project
  (Netherlands)
  Focusing on change in the classroom, curriculum, and school when researchers and teachers work closely together on computer integration into curriculum areas

- School No. 56 (Bucharest, Romania)
  Programming, computer games, and other educational software as tools to improve students' creativity

- "Comptown" (Emory, Israel)
  What happens when an entire town becomes involved in technology-enriched schools? An investigation of the "ecology of a computer culture" in schools

- F. M. Black Middle School (Houston, Texas)
  Computer enrichment to support the curriculum; business partnerships and strong school leadership

- Quinte Lighthouse Project
  (Belleville, Ontario, Canada)
  Moving teachers past the project stage and into "post-project rejuvenation"

- Netherhall School (Cambridge, United Kingdom)
  How an "ordinary" school can become involved in a series of technology-enriched projects and effectively integrate technology throughout its curriculum

Mount Newton Middle School: A Technology Enriched Middle School

by Keven Elder[1]

1. Background, Intentions, and Context of the Project

The Saanich School District in British Columbia, Canada is building a replacement for Mount Newton Middle School. In Saanich, a middle school covers Grades 6 through 8, where students range in age from 10 to 14 years.

The intention is to prepare a "technology-enriched environment" that allows for thorough and appropriate uses of computers and related technologies for learning and teaching, as well as administration. This paper is intended to describe the project, and in doing so to focus on the central element of success, namely the staff development program.

1.1. Background

Instructional uses of technology are undergoing careful scrutiny in British Columbia as elsewhere in the world. We have come through three eras of computer use in schools, from studying about computers to studying with computers, then on to using the computer as a tool (word processing, graphics, CAD, etc.) While we are still relatively new to effective tool uses of technology, we are now entering a fourth era, one of the computer as an agent of curricular change. How we teach, what we teach, and when we teach it are being re-thought by teachers in light of the opportunities afforded by technology. It is in this light that the Saanich School District is building a new technology-enriched middle school that can address fundamental questions about the role of computers in learning and teaching.

At the same time, education in British Columbia is undergoing dramatic and fundamental changes as a result of a thorough government study, known as a Royal Commission, undertaken in 1987. Grade levels are being replaced by Primary, Intermediate, and Graduation Programs; curriculum has been integrated into four strands (Humanities, Math/Science, Fine Arts, and Practical Arts) to be equally represented in all years of schooling; students with special needs are integrated into standard classroom settings; curriculum is being redesigned from the ground up on a learner-centred, individualized model; assessment and evaluation are shifting to descriptive from prescriptive with the probable removal of letter grades; and parents have a stronger, legitimized voice in school matters.

Mount Newton Middle School, located in the rural-suburban municipality of Central Saanich, is one of three Grade 6-8 middle schools in the Saanich School District. It houses 640 of the district's 7000 students, plus a staff of 40 teachers and 20 support staff. District programs for students with special needs are housed at Mount Newton, including programs for Educable and Teachable Mentally Handicapped students, and students with Severe Learning Disabilities. A strong Native Education program serves the 70 Native Indian students.

The 61 year-old school is bounded by a gravel pit and a much-traveled roadway and is scheduled to be vacated for a new school in the fall of 1992. Originally scheduled for a September 1991 opening, a number of issues have caused its delay, including Agricultural Land Commission dealings and a move to new property following a Native Indian land claim.

1.2. The context

The Mount Newton project is an outgrowth of a series of technology pilot programs, which the school district undertook between 1987 and 1989. During this time, we entered into numerous high-profile partnerships in an attempt to help define the role of new technologies in classrooms. Classroom telecommunications, satellite trials, "multimedia" for classroom or specialized use, computer-managed learning systems, and electronic data access were explored and evaluated extensively. Two years of exploration gave way to consolidation in 1989. In the final analysis, we won some and we lost some, but a spirit of innovation had developed, as had a credibility with key business and government agencies.

The district was also in the process of planning the replacement school. Following extensive discussions with the Ministry of Education we were given flexibility within planning and construction funds to prepare a facility well suited to uses of technology for teaching and learning. We then formed three key partnerships toward that end.

1.3. The partners

The first partnership for Mount Newton was with the Education Technology Centre (ETC) of British Columbia, located within the bounds of the Saanich School District. With a mandate to promote effective use of computer technology in British Columbia schools, the ETC was established to provide leadership in teacher inservice, research and development, and telecommunications. As a neighboring school, Mount Newton was established as a "field research project," determining with Centre staff the most effective ways to prepare teachers for uses of technology. Funding and support from the ETC and the district allowed the school to launch a thorough inservice and planning program beginning in the 1989-90 school year. Various other projects are also underway, including action research and multimedia explorations. As well, space was

[1] Keven Elder, Director of Instruction (Technology), Saanich School District, 2125 Keating Cross Road, P. O. Box 2000, Saanichton, British Columbia, Canada, V0S 1M0.

allocated within the new school by the Ministry of Education for ETC activities.

The second partnership was established with Apple Canada. It happens that the computer system of choice for Mount Newton, as it is for most schools and teachers in Saanich, is Macintosh. The project described in this paper was seen to be of sufficient benefit to Apple Canada that they will provide a price reduction for equipment purchased for the new school, and expert assistance in the preparation of implementation plans. As well, Apple Canada has provided the loan of 12 Macintosh and 2 Apple IIGS computers, plus peripherals, for dedicated use in our staff development program. Vendors of peripherals and software have entered into "piggyback" arrangements.

Finally, we are working extensively with the Faculty of Education at the University of Victoria. During 1989-90, working under sponsorship of the ETC, faculty members conducted a review of planning and inservice activities at Mount Newton. During 1990/91, collaborative action research is underway with UVic, with six Mount Newton teachers addressing research questions related to the role of technology in writing, language acquisition, science learning, and social and human interactions. The planning review will be covered in Section 3 of this chapter under "Teacher Involvement, Inservice, and Support." Action research will be discussed in Section 4 under "What is Happening?"

1.4. The key participants

The UVic inservice review clearly indicates that the success of the new-school technology planning process is rooted in the staff development program, and that the success of the staff development program is rooted in the roles of inservice leaders and inservice participants. These roles are described briefly here, as are roles of other key participants in technology planning.

1. *Mount Newton Inservice Leaders:* 0.67 release time has been provided by district and ETC funding for staff leadership. Three of our teachers use this time to prepare and deliver inservice, to provide mentorships for colleagues, and to oversee the technical and instructional issues related to technology. This time spent with staff is the critical necessary factor in developing effective instructional uses of computers in our new school planning.

2. *Mount Newton Teaching Staff:* The 36 teachers at Mount Newton were not selected for the new school based on their having unusual computer expertise. The profile giver below is probably typical of middle schools in our area, making Mount Newton a good testing ground for a technology staff development program.

Female	21
Male	15
Median age range	30-39 years
Total years teaching (mean)	13.9
Number of years at present school (mean)	5.6

- Data collected from a survey to which 22 teachers responded follows:

a. How long have you been involved in using computers in education, not counting this year?

Years	Number of teachers
0	1
1	1
2	12
3	0
4	2
>4	6

b. In your use of computer integration, do you consider yourself to be a:

nonuser?	1
novice?	5
intermediate?	13
old hand?	1

c. Have you received formal training in computer integration (workshops, courses), not including this year?

Yes	18
No	4

d. Are you currently in the first or second year of use of some major innovation or program other than computer integration?

Yes	9
No	12

3. *Mount Newton Support Staff:* The school's computer aide is another key player in the entire planning process. She facilitates computer use for teachers and students through her intimate knowledge of the school, students, teachers, and teaching process. In addition, she plays a key technical support role. Mount Newton also houses district Special Education programs resulting in an extraordinary number of paraprofessionals (16). They are included in inservice activities, allowing for them to work knowledgably with students in computer settings. As well, school secretaries participate actively in the inservice.

4. *School Administration:* The Principal and Vice-Principal are active participants in inservice and computer use, but more importantly provide the school with strong

administrative leadership that facilitates a school-wide focus on computer integration. The principal is widely acknowledged as a key factor in all school successes, which are many and varied.

5. *District Administration:* The Senior Executives have also played a facilitative/leadership role in the technology planning. Staying directly in touch with progress and bringing district initiatives to bear (funding, liaison with ETC and Ministry of Education), the Superintendent of Schools, the Superintendent of Physical Plant, and the Secretary Treasurer are key facilitators of this project.

   The district has also seen fit to provide for direct administrative support in the form of a project leader (Director of Instruction—Technology). This project has had an unusually large number of components, including school technology program design, staff development, new-school technology design, new-school networking, new initiatives (school administration, library automation, etc), and liaison with the district, the ETC, Apple Canada, UVic, the Ministry of Education, the architect, and Apple's "human resource network." Without this dedicated administrative leadership (currently approximately half-time) the overall Mount Newton technology planning program would be difficult to focus.

6. *The School Board:* Obviously, all key decisions regarding overall direction and planning are made by the Board of School Trustees. From the beginning of the technology planning process, the Board has been involved and supportive.

7. *The Architect:* In designing and building the new school, we are fortunate to have a forward-thinking architect who works well with all staff. This relationship, combined with vision, his connections with consultants, and strong working relationship with the district and the Ministry of Education, have resulted in a plan that fully integrates technology school-wide.

8. *Education Technology Centre:* We have a unique and productive relationship with the ETC as outlined throughout this paper. Our ability to interact daily with key players at the ETC allows for the Mount Newton project to thrive, and by extension benefit the entire district.

9. *University of Victoria:* The evaluation/monitoring relationship with the Faculty of Education has evolved into a close partnership in research, which also facilitates connections to other post-secondary institutions.

10. *Apple Canada:* Our planning has been actively supported by Apple Canada. Apple Canada's local dealer, Advantage Computers, provided critical networking consultation.

11. *Other Saanich Educators:* Benefits of the Mount Newton experience are starting to accrue to other schools. To this point this is primarily through shared expertise, access to resources and inservice, and liaison to the ETC, but we expect to see a significant impact on teaching and learning in all Saanich schools as we come up with tangible results from our Mount Newton experiences.

2. Organization and Goals of the Project

In preparing for a technology-enriched replacement school, we have identified two distinct phases within the project, namely the planning and implementation phases, each with its own goals. We had expected that most of the implementation issues would be addressed only in the new school. We are happy to have been proven wrong on that point. Planning for effective, school-wide use of computers has very little to do with a new facility; it has instead a great deal to do with teachers' attitudes and dispositions. A strong, well supported staff development program has proven to be the foundation of our success.

In this section, I will describe the way the project is designed and administered, followed by the planning and implementation goals, then a description of the way computer systems are used within the project. Following that will be a section describing the heart and soul of the project, the staff development program.

2.1. Project design

The Mount Newton planning process falls within the framework of new school design. As such, it take a number of years for the need for a new school to percolate to completion. During that time, school districts can prepare in a variety of ways, one of which for Saanich was to have the school's teaching and administrative staff develop education specifications that led to the Educational Program document. From this, the architect was able to prepare the design for the new school. While new school planning is well documented in the literature, I must emphasize here the importance of thorough staff involvement in planning and design. Having an architect who wishes to work with teachers and who values their input is critical.

When the Ministry of Education and the B.C. Education Technology Centre presented the opportunity to plan extensively for technology in the new school, the project took a new twist. While the "key players" were described earlier, the importance of administrative and political leadership should be noted here. The Board of School Trustees must have ownership, as must district and school administrators. In our case, the Superintendent of Schools, the Superintendent of Physical Plant, the school Principal and Vice-Principal, and the district's

Director of Instruction for Technology meet regularly based on need and timing. Lines of communication are open and work in all directions.

At the school level, teaching staff have made technology planning a central issue. With strong leadership from a principal who is truly an educational leader, they embrace new directions openly and with professional control.

As part of the new school planning process, the entire staff worked to put together a new school Technology Program document as an extension of the Educational Program. The Technology Program describes the global and provincial perspectives; the technology philosophy and goal statements of Mount Newton; the means of integrating technology use for learning, teaching, and administration; the hardware and software options for the new school; a computer networking topology (see the appendix of this chapter for details); and extension technologies such as video.

While we rarely put this document front and centre in our discussions, it has provided a solid backdrop for decision making in that it is teacher generated and student centred. While "technology experts" in the school could generate such a document, the fact that it is generated from philosophy and goal statements created by the teachers provides integrity for the entire program.

2.2. Planning goals and strategies

The following goal and strategy statements were generated by the staff early in the planning process (1989) and formed the basis for the planning document noted above. They are intended to better define the program of activities currently underway.

Planning Goal 1: School Computer Use

To develop and implement a thorough and effective program of computer use in support of learning, in a way that reflects Mount Newton's instructional computing philosophy and goals. This program of computer use will fit within the parameters of available hardware, software, inservice, and personnel support.

Strategies:

- Develop and implement an effective staff development program (see Planning Goal 2).
- Work with district and school administration to maintain the effective program of leadership from lead teachers on staff.
- Work with lead teachers to establish partnerships or mentorships within Mount Newton staff, with an eye toward documenting computer-use outcomes such as teaching units.
- Monitor the program of activities to define and assess "thorough and appropriate use of technology for teaching and learning" (as stated in the Technology Program paper).

Planning Goal 2: Staff Development

To develop and implement a staff development program which will enhance each teacher's comfort, attitudes, and abilities in the areas of:

a. personal productivity;

b. use of the computer as an instructional tool;

c. record management; and

d. integration of computer use into curriculum for the benefit of student learning.

Strategies:

- Work with lead teachers, school administration, Education Technology Centre staff, University of Victoria faculty and all staff to develop an ongoing plan for staff development.
- Include in the inservice plan opportunities for personal in-service relevant to participants' needs (instructional inservice) as well as classroom support for curricular integration (via mentorship).
- Ensure implementation of the plan with proper monitoring, including keeping a file of activities and reports.

Planning Goal 3: New School Preparation

To prepare, in support of the planning goals and the school's technology philosophy and goals:

a. a reasonable "technology program" for the new school, describing all computer uses in support of teaching, learning, administration and specific program areas;

b. a "technology-enriched environment" in the school itself, as described in the technology program document.

Strategies:

- Maintain currency of the technology program document, with as much staff involvement as possible.
- Develop with the school and the district a five-year plan for expenditures, including hardware, software, personnel, network, ongoing maintenance, and so on.
- Maintain a close liaison with district executive regarding land, budget, construction, and technology-design issues.
- Stay involved with the school planning process via the Superintendent of Physical Plant and the architect, in

order to assure funding for computer acquisition and continued involvement in the design and installation of computer and networking systems.

- Be positioned to move quickly on purchase of hardware, software, networking and peripheral equipment.

Planning Goal 4: Extension of Activities

To extend computer activities within the school to curriculum and administration areas which have not yet been thoroughly addressed.

Strategies:

- Complete implementation of the school-based administrative program (MacSchool), including networking for multi-user access for all functions.
- Complete library automation by the end of 1990/91.
- Explore and implement computer use in the music program.
- Continue planning for the new Technology Education program, working with the Ministry of Education regarding new programs.

Goal 5: Validation/Documentation/Extension

To work with technology partners, particularly the Education Technology Centre of B.C., The University of Victoria, and Apple Canada, to pursue optimum uses of computers in education, in order to make the best use of the technology during planning phases and in the new school.

Strategies:

- Continue in active partnership with the Education Technology Centre in terms of evaluation, ongoing planning, and projects (such as the Intermediate Field-Based Development project).
- Extend and nurture the UVic/ETC evaluation program from monitoring of inservice to "collaborative action research" dealing with the true role of computers in support of learning.
- Continue in active partnership with the "Christopher Columbus Consortium," as one of six international partners in a 23-member school-university instructional computing cooperative.
- Continue involvement with the international research project ITEC (Information Technology in Education and Children).
- Continue to work with the ETC in terms of planning for the new school, both for technology integration and the use of ETC space in the new school.

2.3. Implementation goals

The following philosophy, guiding principles, and goal statements are taken directly from the Technology Program document authored by Mount Newton staff.

2.3.1. Philosophy Statement

At Mount Newton Middle School, we believe that technology can support education by:

- facilitating active learning;
- empowering each student to fulfill his or her own potential;
- preparing students to meet the demands of a rapidly changing society;
- providing tools for teachers to enhance instructional practice;
- facilitating effective classroom management and school administration.

2.3.2. Technology-related goals

In generating goal statements, we were attempting to cover all aspects of the school program as appropriate. We considered student learning, instructional practice, and school or classroom administration. While it seemed natural to categorize by subject area, department or grade, we already have significant momentum toward integrated subject areas, and may soon be operating within an ungraded structure. As a result, the goal statements have been left as general as possible in order to accommodate a variety of possibilities within the province's new Intermediate Program (Grades 4-10).

Some of these goals are more measurable than others, perhaps meaning more prescriptive than descriptive. We have attempted to make all goals clear, attainable, and measurable. This list is non-hierarchical, not exhaustive, and will be constantly reassessed. For now, these goals will serve as guidelines for decisions related to inservice, hardware, software, and networking.

2.3.3. Guiding principle

Computers and related technologies will be integrated with the education process at Mount Newton Middle School only in support of learning and instruction, as a means of enhancing the human and social experiences of schooling.

2.3.4. Computer implementation goals (#1-17)

1. The use of the computer as a general-purpose tool to support student learning shall be integrated throughout the curriculum as appropriate. Students will make regular use of word processing, database, graphics, telecommunications, and other general-purpose application packages.

2. The use of multimedia technologies shall be integrated throughout the curriculum in support of student learning.

3. Students will have ongoing access to electronic information, both on-site via storage devices such as CD-ROM, and remotely through telecommunications. This access will be within the library/resource area, and school-wide as possible.

4. By the end of Grade 6, each student will be able to use a word processor to support process writing and will be skilled at composing and editing at the keyboard.

5. By the end of Grade 8, all students will have attained a high degree of proficiency in computer input (currently keyboarding).

6. By the end of Grade 8, all students shall be comfortable with technology, with each student having a broad-based interdisciplinary knowledge of applications, limitations, and societal implications of computers and related technologies.

7. All students will use word processing technology, integrated with other computer applications such as graphics as appropriate, in support of the writing process in all curricular areas.

8. By the end of Grade 8, each student will have worked with computers and/or related technologies in support of practical activities within the curriculum, including science experiments, fine arts activities including music and art, and practical arts activities including home economics and industrial/technology education.

9. By the end of Grade 8, all students will be able to demonstrate a high degree of skill in accessing and manipulating information stored in a computer database.

10. When it is pedagogically and economically sound, computer-assisted instruction (CAI) may be used to enhance student learning. CAI includes drill and practice, simulations, and tutorials, and may include computer recording of student progress.

11. Technology will enhance the process of mainstreaming students with physical and/or mental disabilities into the regular classroom.

12. Students who have deficiencies in written language skills will have high-priority access to time and support to use a word processor to complete assignments in all subject areas, and will be able to access independent learning modules that will assist in strengthening areas of weakness.

13. Students who have deficiencies in basic computational skills will be able to access independent learning modules that will assist in strengthening areas of weakness through drill and practice.

14. By the end of Grade 8, all students will be able to use a computer to:

    - demonstrate the use of a spreadsheet for the purpose of recording and organizing data;
    - demonstrate a facility with portraying data graphically;

15. By the end of Grade 8, all students will have:

    - been exposed to computer simulations;
    - been exposed to multimedia presentations on a variety of topics;
    - experienced interactive learning on a variety of topics at student workstations.

16. Technology will be used as a means of data evaluation to determine fitness levels, through the use of fitness-evaluation software.

17. Computers and related technologies will be used to supplement programs in specialty areas, including Music, Art, Physical Education, Business Education, Home Economics, and Industrial/Technology Education.

2.3.5. Instructional goals (#18-21)

18. The use of the computer as a general-purpose instructional tool shall be integrated throughout the curriculum. Teachers will have opportunities for regular use of word processing, database, graphics, telecommunications, and other general purpose application packages.

19. Teachers will have opportunities to use interactive video or similar technology, including CD ROM, as available and appropriate for instructional purposes.

20. The professional staff shall have opportunities to use computers and related technologies to enhance their productivity and effectiveness in instructional and management matters.

21. A technology-related staff development program will be a high priority in professional development activities, in order to maintain currency with the emerging opportunities afforded by technology.

2.3.6. Administrative goals (#22-26)

22. Computers and related technologies shall be used to support administrative processes within the school, including demographics, attendance, reporting, and timetabling.

23. Professional staff will have access to a school-wide administrative computer network that will allow for electronic mail, file-server access as necessary, and access to office administrative information as appropriate.

24. By September of 1991, the Mount Newton Middle School library will be automated for inventory, catalog, check-out, and security purposes.

25. Computers and related technologies will be organized within the school in such a way as to accommodate guest visits without affecting the learning environment adversely.

26. Mount Newton Middle School will work to integrate the use of computer technology into assessment and evaluation practices within the new Intermediate Program, particularly in the area of individualized Learner Profiles.

2.4. Computer access within the project

The fourth section of the paper (What is Happening?) describes computer uses, but it may be of value here to put into perspective just what is meant by "technology-enriched" at Mount Newton. How are computers currently allocated, and what will be the allocations in the new school?

2.4.1. Current computer allocations

The existing Mount Newton Middle School is a traditional two-story (plus a basement) school, typical of high school designs of the 1930s.

The training lab on loan from Apple Canada is located on the main floor next to the library. It contains 24 Macintosh computers networked with MacJanet, as well as a laser video player, a CD ROM player, a liquid crystal display for whole-class projection, a flatbed scanner and two Imagewriter printers. While this lab's central purpose is for teacher inservice, we routinely have entire classes using the lab in a way which allows teachers to extend what they have learned. As such, "leading edge" is often seen here, including Journalism, Hypercard, and interactive laser video activities.

In the library, a computer is connected to a CD ROM player for electronic encyclopedia use. We are currently awaiting further funding in order to complete the process of automating the library.

The school office contains three computers, two being Macintoshes connected to a laser printer for office productivity. The third is a Wang terminal connected to the district office system. The head counsellor has a terminal in his office, as well as the file server for the school administrative software package, MacSchool, running on AppleShare.

A teacher workroom contains four Macintosh computers on their own MacJanet network. The laser printer is also located here, as its main use is teacher productivity. It can, however, be accessed from anywhere else in the building via network cabling.

A second computer lab is located downstairs. Here, 28 Macintosh computers reside on a two-part MacJanet network. All teachers book into the downstairs lab for a wide variety of activities.

Other computers are located throughout the building, especially in the Special Education areas. Learning Assistance, Native Education, Severe Learning Disabled, and Educable and Teachable Mentally Handicapped programs have their own unique needs for computers. Music Education equipment is currently on order.

2.4.2. New-school computer allocations

The new school is designed for 750 students, with the layout allowing for a school-within-a-school concept. Our assessment of computer labs versus clusters or individual computers has come up with a clear answer . . . all of the above. Entire classes will require access, as will small groups or individual students on a nearby, as-needed basis. Thus, each pod will have a computer lab of 28 networked computers, as well as two clusters of six networked computers, and various single workstations throughout the pod.

It is our best professional judgement that students should have access to computers for approximately one hour per day, resulting in an approximate ratio of five students per computer, or 150 student computers in the new school. While this number may seem low to many computer afficianadoes, it is our opinion that in a five-hour school day, middle school students will spend the vast majority of their time in non-computer pursuits.

We also project a need for ready access to computers for teachers. Personal productivity, lesson support, teaching with whole-class display, and daily record keeping will require a computer in each teaching area dedicated to teacher use. As well, the school network design must be able to support a teacher environment that is separate from that of students, but which can access student networks.

Administrative and library automation functions add a further need, bringing the full computer allocation to 232 for the school. Whether we can attain the level of funding will be determined in the coming months as the district allocates funds to various aspects of construction.

3. Teacher Involvement, Inservice, and Support

3.1. Background and expectations of teachers

In January of 1989 we secured the funding to begin a concerted inservice program at Mount Newton. Released time was provided for teachers, including significant release time for three inservice leaders on staff. Choosing an inhouse model of "mentorship inservice" was perhaps the single most important decision of the entire process. And having the right people on staff made it relatively easy in its implementation.

One of the reasons we look to this project as a model for other schools is the fact that we are working with an existing staff. It is significant to note that we were not moving to a new school with hand-selected technology-oriented teachers. We are planning for a replacement school with a "typical" (albeit excellent) middle school staff. As of January, 1989, these teachers were relatively unaware of the uses and potentials of computers for teaching and learning, in fact the majority were not personal users, let alone classroom users.

The University of Victoria's review of our January to June, 1989, inservice program, using attitude and perception scales plus interviews and workshop evaluations, served as a monitoring and planning mechanism during the early stages of the program.

3.2. The inservice program

Our University of Victoria faculty partners provided a literature review of inservice. The following synthesis of research into key components of effective inservice has been used to assist us in our planning:

- Set clear goals for staff development;
- The content of inservice education programs should be directly and immediately linked to the goals of the school;
- Recognize that, at present, curricular integration of computer technologies is problematic for many teachers;
- The characteristics of teachers as adult learners should be taken into account when inservice activities are designed. In particular, the activities should be relevant to them as adults, new knowledge should be explicitly connected to previous knowledge, an air of informality should predominate, grading systems should be avoided, and the trainer should act as facilitator;
- Provide inservice activities that allow for hands-on learning;
- Recognize and accommodate the different skill levels that exist among teachers and between workshop facilitators and teachers;
- Designs that feature multisession contact and development of an ongoing relationship between trainer and teacher are preferred over one-shot designs. Develop inservice programs that have a long-term focus;
- Provide time for teacher discussion, planning, and workshop follow-up. The training should include not only presentation of information and demonstration of new methods and skills, but also supervised practice and coaching;
- Provide teachers with ready access to facilities;
- Provide strong support services within the school.

The staff development program is the cornerstone of our success in defining "thorough and appropriate uses of technology." Under the leadership of our on-staff mentors, the staff development program has three program components, namely:

1. Familiarity/Personal Productivity: Here, teachers are exposed to application tools such as *Microsoft Works*, *HyperCard*, and *MacSchool Marks*, where they are provided with directed inservice in the use of the programs.
2. Classroom Applications: Our lead teachers, working with our computer aide Penny McLeod, assist teachers in extending their application skills into support for student use in the computer classrooms areas (as outlined earlier). Many of the ideas for classroom use are introduced during directed inservice.
3. Curricular Integration: Teachers have adopted computer use in support of classroom activities, without the activity being initiated or even supported by a lead teacher. An example would be the incidental use of spreadsheets to support data analysis in science.

Early in the inservice program (January to June, 1989), and through most of the 1989/90 school year, we offered full- or half-day workshops for 6 to 10 teachers, each with released time. These were usually offered in a series that corresponded roughly to the first and second of the components noted above. For example, one of our lead teachers would offer a workshop in introductory uses of an application tool such as *Microsoft Works* word processing or *HyperCard*. He or she would follow up individually with teachers on their own time, then judge when their personal skills were such that they could be expected to apply these skills to the classroom. This would give rise to a second workshop on classroom uses of the application. The third component, curricular integration, tends to occur without workshops. Our lead teachers provide this level of inservice personally for teachers, working with them to develop new avenues of

curriculum and delivery based on their new skills and aptitudes.

Throughout this sequence, the teachers are the driving force. The lead teachers feel out individual needs and match them to inservice or mentoring activities.

This is not an inexpensive model. School-wide computer inservice involves a number of keys for success, including dedicated computer use (afforded through Apple Canada's loan of Macintosh equipment for our teacher training lab next to the library), and funding for release of lead teachers as well as teachers themselves for directed inservice (provided through grants from the Education Technology Centre and the school district).

It is also worth noting that we are gaining great insight by staying in tune with current research, including findings from the Apple Classroom of Tomorrow (ACOT) project that delineates five levels of personal growth of teachers in a project such as ours. [2]

[2] The source of this information is David C. Dwyer, ACOT Project Manager and Principal Scientist, Apple Computer, Inc., Cupertino California.

The five ACOT levels are:

1. Entry:
   Introduction and planning, such as occur in our first inservice component directed at personal productivity.

2. Adoption:
   Software and nuts-and-bolts technical training, with teachers becoming independent in computer use.

3. Adaptation:
   Smooth integration of software applications into existing instructional practice, plus modifications in courses of study to take advantage of increased productivity. Introduction of other software and other technologies such as interactive laser videodisc.

4. Appropriation:
   Experimentation with interdisciplinary projects, as well as team teaching and student grouping. Teachers work in peer and mentor groups.

5. Innovation:
   Integrated curriculum and balance of direct teaching with project-based teaching. Integration of alternative modes of assessment. Collaboration between teachers and researchers, with teachers writing about experiences.

By observing our teachers in light of this model, we are able to target our inservice activities in terms of which teachers require which of our three inservice program components described previously. We are also able to better determine timelines in terms of directed inservice and follow-up. Also, we are attempting to identify computer-oriented classroom activities at Mount Newton that fit into the ACOT levels of personal growth. For example, humanities teachers developing teaching units that integrate computers and writing demonstrates Adaptation, while math and science teachers working together to integrate spreadsheet use into lab work would demonstrate Appropriation. Innovation level activities could be said to be occurring in journalism and enrichment (Hypercard activities), and with all teachers involved in collaborative action research with the University of Victoria.

4. What is Happening?

4.1. Staff development

During 1990/91 and 1991/92, we are using lead-teacher release time to move teachers individually and collectively through our three levels of inservice and the five ACOT levels. We are gradually moving from dedicated inservice to peer mentorships, with our staff leaders providing one-on-one assistance in classroom and curricular integration. Mentors are working with teachers based on matching our inservice components to teachers' stages of personal growth (ACOT).

The UVic planning review provided the following recommendations as we moved into our second year of staff development:

- Plan workshops of interest to subject-area groupings;
- Structure inservice to allow teachers to develop instructional units that are based on common subject-area interests;
- Encourage teachers to visit other classrooms to observe how others are using computer technologies;
- Provide release time for inservice and mentoring activities;
- Provide adequate time during and between workshops so that participants can master concepts;
- Allow teachers to take computers home;
- Continue to have Mt. Newton teachers as inservice leaders;
- Ongoing coaching and support should supplement workshops;
- Invite "experts" in to teach model lessons.

Each of these recommendations is considered in planning and implementing inservice. In particular, the mentorship/partnership approach is being explored and extended within and across curricular areas.

4.2 Classroom activities

4.2.1 Computer-curriculum activities

Classroom activities underway and growing in momentum include:

- *Writing Activities.* Following personal productivity and classroom application inservice, more than 75% of Mount Newton teachers make regular use of the two Macintosh labs for writing activities in all subject areas, primarily with *Microsoft Works* and *SuperPaint*, or *HyperCard*. A "Sharing" folder on the Macintosh networks allows teachers to design and share computer-based writing activities. French Immersion and French as a Second Language students make regular use of French word processing and *HyperCard*.

- *HyperCard Activities.* 12 Mount Newton teachers have had formal *HyperCard* training, and are now comfortable using commercial stacks, as well as designing their own stacks or templates for student use, or integrating stack design into classroom activities as appropriate. Many teachers are now moving to *HyperCard* writing activities that integrate writing, graphics, digitized scanning, sound, and animation, often with templates (predesigned *HyperCard* screens).

  Science and Math. Teachers have developed applications of databases and spreadsheets for data analysis. Laser video applications are also being explored using Space Archive, Brittanica and National Geographic discs. A *Windows on Science* laser videodisc is being used in conjunction with a school-designed *HyperCard* front end for Science 7.

- *Special Education.* Students make regular use of computers, primarily for writing, with the support of their teachers in the EMH (Educable Mentally Handicapped), SLD (Severe Learning Disabled), Learning Assistance, and Native Indian Education programs.

- *Enrichment. HyperCard* has become a staple program for enrichment students working with stack design enhancing thinking and problem solving skills. Students are designing *HyperCard* stacks as a means of data collection and presentation of research projects, linking where possible to interactive laser video.

- *Journalism.* A 12-week Unified Arts course turns out a highly professional student newspaper, comparable to any produced by a high school journalism program.

- *Library.* CD ROM-based encyclopedias are accessed routinely by students using CD Groliers in the DOS and Mac environments.

- *Guidance.* STM Systems Corporation of Victoria has provided Mount Newton with their "Choices" career decision-making software package for the Macintosh. It is currently being used extensively in the Grade 8 Guidance program.

4.2.2 No "separate" computer courses

It is worth noting that we had eliminated all "computer studies" courses in the school in order to focus all computer time on classroom and curricular support, particularly in the area of writing. We found, however, that students required formal keyboarding instruction, and have thus introduced a three-week unit for most Grade 6 students, using a commercial Macintosh keyboarding package.

4.3 Other school functions

We are also working to extend computer activities within the school to curriculum and administration areas that have not yet been thoroughly addressed. Two are administrative in nature, while two are curriculum related. All four areas should be actively explored, and/or implemented before we move to the new school.

- Complete implementation of the school-based administration program (MacSchool), including networking for multiuser access for all functions by the end of the 1990/91 school year. Currently, Mount Newton is using the Attendance module daily, and has now made a complete conversion to computer-based reporting through the Reporting module. All teachers were already using the Marks program, so for them the transition was relatively straightforward (with the exception of a number of process-related hurdles and headaches). We are also ready to fully implement scheduling.

- Complete library automation. We have had the bulk of our library records converted to electronic Mark Record MacSchool format, and will purchase the equipment to make the full transition as soon as finances allow.

- Exploration of computer use in the Music program. Included here will be the use of a computer and keyboard with MIDI interface, as well as computer-based composition.

- Continued planning for the conversion of Industrial Education to Technology Education, as per the new Intermediate level program being designed by the Ministry of Education. This program redesign will need to be made in time for purchasing of equipment for the new school.

4.4 Collaborative action research

During the spring of 1991, six Mount Newton teachers began a collaborative action research project in cooperation with members of the Faculty of Education of the University of Victoria, under the sponsorship and coordination of the Education Technology Centre.

This project arose out of a staff meeting in October of 1990, where we posed two questions to the teaching staff. To us, the answers were telling indicators of the success of dedicated, teacher-led inservice, and of our teachers having evolved through to higher levels of personal growth on the ACOT model.

The first question simply asked how many hours per school day middle school students should be able to access computers for learning. Every teacher said at least one hour, with many saying three to four hours, with the most common response being two to three hours, or roughly one-half of their time in school.

The second question asked what questions teachers had regarding the uses of computer technologies in schools. All responses centered around the question of the real difference that computers make to student learning. This response was welcomed. It seemed to indicate that teachers want to work in the cognitive and metacognitive realm regarding computer use, rather than either accept blindly or reject out of hand.

Out of these expressions of interest came a series of meetings with UVic faculty and ETC staff regarding school-based research. Six teachers are now undertaking four research projects with faculty partners examining the role of computers and related technologies in language acquisition, writing, and science learning.

Collaborative action research literature has been clear on the need for regular meetings and an openness among group members to the kinds of issues that enhance or impede the project. At Mount Newton, the six teachers have met roughly monthly, with the most popular and productive format being a meeting in somebody's home, rather than at the school. Reflective discussions take on a deeper and more meaningful tone when these teachers are away from the school. We are fortunate, as well, to have formed strong relationships with our university faculty partners, and to have legitimized the research through the granting of postgraduate credit.

5. What are the Effects of the Project?

5.1. Results so far: Teacher perspective

What a difference a year makes. While we have not replicated the attitude and perception measurements (while realizing that we should), it is clear to those of us coordinating these efforts that teachers are making significant progress, whether measured on program component or on personal growth (ACOT) indicators. Workshops are on the way out, with the exception of small-group activities to allow some teachers to catch up. Mentorships are on the increase, where teachers will work together to develop a curricular application; and the mentors are not always our lead computer inservice teachers. The circle of involvement is widening.

Interestingly, very few people make any effort to connect their personal growth or the inservice planning to the Mount Newton computer-use goals described earlier in this paper. The goals seem to be providing a vague backdrop to decision making, rather than a focus. This may mean teachers are happy with the goals they generated, or it may mean they don't care a great deal about these goals. The goals will be revisited during the next few months as Mount Newton revises all school goal statements.

One measured indicator of where teachers are and where they wish to go was provided out of our 1989 inservice evaluation completed by the University of Victoria. From this evaluation, the following findings allowed us to plan effectively not only for further inservice but for new-school technology planning (all of the following were measured during January to June, 1989):

- *Attitudes*: Teachers' attitudes towards microcomputers and related technologies are positive, with a desire for students to have ready access to computers. Teachers are also interested in using technology in classrooms to teach activities that involve students in problem solving. At the same time, they express concerns regarding student isolation, and they question whether computers will make better thinkers of students.

- *Perceptions*: Teachers expressed a clear desire to improve their uses of technologies and to interest students in using computer technologies. Teachers also need to feel a strong support system of both personnel and support materials to enable them to successfully integrate technology use into classroom activities. They also wish to coordinate activities with other teachers, and to have means of ensuring a positive impact on the students' total school experience.

- *Workshops*: Dedicated inservice in areas such as *HyperCard* are seen by teachers to be valuable if they are practical for teachers' personal productivity and classroom use. Teachers would like time during inservice to modify and develop activities for their classrooms. 56% felt competent integrating software programs and activities from workshops into teaching; 50% felt they would increase instructional uses of computers with students; 50% expressed a desire to have a workshop leader work directly with them in classrooms; 44% felt that too much information was presented for them to absorb comfortably.

- *Interviews*: Teachers believe that the computer is best used as a tool for instructional delivery. There was a recognition that the computer can influence not only the method of instructional delivery, but the way in

which curriculum is conceptualized. Teachers see an increase in student interest, greater ease of student writing, and possibilities for new avenues of learning all coming about as a result of helping students to work and learn with computers. When asked about personal benefits for teachers, most spoke about how the computer allowed them to do a better job of teaching, with increased individual attention and meaningful feedback for students. Classroom materials and marks management were seen to be valuable as well.

To quote further from the report:

In general, teachers hold a positive view of the computer-focused inservice they have received to date. They recognized a high degree of administrative support that is being given to the uses of educational technology and felt that the workshop and inservice leaders were doing a good job in moving the staff toward a high degree of (instructional) computer expertise.

The teachers have enthusiastically embraced the staff development program, and it is a safe generalization to say that there is a noticeable shift from personal productivity to classroom applications to curricular integration of computer use. The inservice model relies to a great extent on teacher release time, with teachers following up the inservice with considerable activity on their own time. Also important is the availability of expert mentors, including the lead teachers, for classroom support following inservice.

5.2. Learning logs

The other "hard data" we have is in the form of "learning logs" for the action research projects. While the research questions are only now being set, student and teacher learning logs are beginning to provide insights. For example, an interactive laser video unit being piloted with a Grade 7 science unit on the human body reveals the following insights. An associated Learning Log Question was:

Was the use of technology helpful in your learning? Why or why not?

The teacher answered this with:

"Yes, students enjoyed the graphic illustrations and picked up on cells, tissues, organs, and systems. They demonstrated knowledge of digestion and circulation systems. Students used it for me! Students are highly interested and motivated."

The following answers were given by students (who worked with an interactive laser video during this instructional unit):

"Yes, because it showed me pictures of everything and it helped me learn more."

"Yes, because it's more exciting than the other ways of learning, as it makes it more interesting. The pictures and diagrams helped me to understand what we were learning."

"Technology is useful because it is fun to learn about computers and the human body."

"It was because it showed great graphics, faster than a teacher on the chalk board."

"Yes, I think it was useful to learn more about your body. It's good because it shows us most of the parts in your body."

"Yes, it made it easier to learn the information."

"Yes, because it was more interesting."

"Yes, I think the technology was helpful. I think it would even be better if each student had their own screen and could interact with the laser themselves (push their own buttons), answering questions on the screen at their own speed."

"Yes, technology makes learning fun instead of using books, which is boring."

"It helped us by showing the whole class a model and the real thing at the same time."
"Yes it was easier to see with the best graphics."

"Yes, because you seem to remember the pictures easier than if the teacher went over it. Also, some of the pictures are cool, such as the heart and the magnified slides."

"Yes, it made it more interesting."

"Yes, because we got to see real pictures instead of drawings on the chalk board."

"Yes, because the lesson became visual."

"Sort of. It was disgusting—we can see what things really look like."

"Yes, because we could see the pictures like the tissues, heart and human body. I think it goes quicker and we learn more."

"It showed us in detail what we were talking about. It is easier to learn."

5.3. Reflections

Recommendations arising out of the Mount Newton project relate primarily to planning for a technology-enriched school, rather than to implementation issues. At the same time, with planning occurring in the existing school with the existing staff, we are implementing strategies and methodologies now, as we will through the opening of the new school in September of 1992.

This may provide the first significant lesson out of our experiences. "Technology-enriched" refers first to the attitudes and dispositions of teaching staff, second to the effects of technology on curriculum, third to availability and use of technology resources, and fourth to facility. Staff development, curriculum integration, and adequacy of resources are essential factors in effective uses of technology. Only when these are properly addressed can a new or remodeled school be considered "technology-enriched." Too often we see schools of the future designed around equipment and facility, without placing staff and curriculum development front and centre in planning. But we all learn from our mistakes. Let's hope we can learn from our successes as well.

Also worth noting here is that we have yet to develop any indicators, other than anecdotal subjective reports, of the difference that any of our computer use makes to student performance. We may begin to see these kinds of measurements through our action research project with UVic.

5.4. Recommendations: Planning for a technology-enriched school

Recommendations within the Mount Newton project are found throughout the chapter, but could perhaps be synthesized as:

- Start with a vision, and adapt it as necessary. Only discuss the vision and other less pragmatic issues when and where the mood and audience are right.
- Put people first, especially teachers and, by extension through teachers, students.
- Don't feel guilty for investing resources in staff development at the apparent expense of students (such as allocating computers to staff). An investment in a teacher will pay off for hundreds of students in years to come.
- Involve staff, students, and parents in planning the educational program, the technology program, and the physical design of any new or remodeled facility.
- Set clear planning and implementation goals for staff development and technology integration.
- Pay attention to the research when designing a staff development model. In particular:
  - Use teachers as inservice planners, leaders, and mentors.
  - Make inservice relevant to teachers personally and professionally, especially focusing on curricular relevance.
- Make inservice long-term, with ongoing support.
- Provide resources for staff involved in the staff development program. Provide leader/mentors with planning and support time, and provide teachers with release time for inservice and follow-up.

5.5. Recomendations for "ordinary" schools

Our recommendations for "non-TES-project schools" are identical to the ones we gave for TES schools, with obvious allowances for adaptation to local circumstances. Try to avoid the "we can't do it because we can't afford it" excuse. When proper consideration is given to all planning issues in schools, the shift from idea to implementation is a simple matter of priority setting. Where somebody has done the groundwork to get computer use solidly connected to curriculum, the agenda will proceed with or without funding.

California Model Technology Schools: The Monterey Perspective

by Kam Matray[1]

There is nothing more difficult to take in hand, more perilous to conduct, or more uncertain in its success, than to take the lead in the introduction of a new order of things, because the innovator has for enemies all those who have done well under the old conditions, and lukewarm defenders in those who may do well under the new.

—Machiavelli *The Prince* (1446-1507)

1. Background, Goals, and Context of the Project

1.1. Statewide initiative

In the early 1980s, the State of California began to investigate the feasibility of three initiatives in educational technology: software development, telecommunications, and model technology schools. Funding for the initiatives was provided in 1987 by Assembly Bill 803, California's first Educational Technology Act. Funding for the continuance of these five-year research and evaluation projects is now provided by SB1470.

1.2 Goals of MTS

The California Model Technology Schools (MTS) Project endeavors to demonstrate the effective use of technology in instructional delivery and enhancement, as well as in school management. It strives to provide policy guidance to government and business decision makers on the best and most cost-effective strategies for using technology to meet California's education goals. The program also aims to disseminate the information necessary for the successful adoption/adaptation of promising practices in similar schools across the state of California.

Lessons learned and strategies developed through the MTS program must be useful to a wide variety of schools and applicable to the broad range of California students. To ensure this broad base, five separate and diverse school districts were selected and funded through a competitive grant process; a sixth site was added during the second year of implementation. Each project consists of a complex of two to four schools spanning kindergarten through twelfth grade (with the exception of one site with one school, Grades 6 through 8). Together, local MTS projects are investigating a range of approaches to the problems of technology integration in schools. Technology is being infused throughout each project's schools at every grade level and in each curriculum area.

MTS projects are developing and demonstrating models of education for the 1990s, models that use technology to successfully meet the challenges facing tomorrow's students. These involve significant change and considerable new learning for administrators, teachers, staff, and parents. They require rethinking the traditional ways that some content is taught at some grade levels. Successful models also discover restructuring the student-teacher relationship and redefining the classroom. As well, MTS projects are very likely providing models for reorganizing the administrative structure of schools and dramatically increasing the level of parent and community involvement in education.

1.3. Three key elements

There are three key elements of the Model Technology Schools plan: developing partnerships, conducting research, and disseminating successes. The MTS partnership is built on shared interests. Public schools, communities, universities, business and industry, and the state all have interests in improved student learning, greater school accountability, and the development of well-researched, educationally sound, and forward-thinking state policies on the integration of technology in schools.

1.3.1. Developing partnerships

The partnership involves sharing responsibility. All partners in a Model Technology Schools project have some responsibility for project management, project support, and project results. Primary stakeholders in the MTS partnership are the state, the educational community at each local MTS project site, research and teacher training institutions, the information technology industry, and other businesses.

The state endeavors to provide leadership by coordinating the management, training, research, and dissemination activities of the six MTS project sites, ensuring that they respond to the policy questions of decision-makers in both government and business. In turn, the state's partnership role includes providing the seed money, $500,000 annually for five years to each of the six MTS projects, with each district providing a $50,000 match.

1.3.2. Conducting research

A research partner helps to formulate the direction of pedagogy and training for the next generation of California teachers by guiding the research function at each MTS project. Research partners construct the measures, collect the data, and track the successes and difficulties for an MTS project.

MTS research is "policy research," not "pure research." This includes testing realistic policy options and identifying those factors critical to the success of each activity chosen for broader dissemination. Measures of success (the bottom line for MTS research) is a combination of improved student learning, cost effectiveness, and

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cost benefits maximizing the per dollar impact for student and teacher technology access.

The business partners at each MTS project help to ensure the productivity of tomorrow's workers, and boost the long-range competitiveness of California's economy worldwide by contributing advanced information technology products, expertise, and management advice. In doing so, they will be better able to respond to and help to shape future technology products for the educational markets.

Business and industry can actively support MTS projects by contributing both products and expertise. In turn, the MTS program provides the information technology industry with research and development sites for field testing new products and their educational applications. When these products are used to meet the educational needs of Model Technology Schools, they can be expected to be useful to other schools statewide.

The success of the MTS program depends, in part, on the strength of the established business and research partnerships. Working together, the MTS program serves as a model to support California's educational improvement efforts in areas such as curriculum, teacher preparation, and accountability in school management.

Teachers, parents, students, and administrators of MTS projects pose the educational questions and frame the technological answers that may change schooling for generations of children. By contributing their expertise, resources, initiative, and energy, they can hope to benefit today from the education of tomorrow. AB 803 and AB 1470 both require grantees to provide a 10 percent match of state funds.

1.3.3. Disseminating successes

Due to the magnitude and complexity of the projects, dissemination of information for the first three years is limited to the processes of implementation. The state coordinates and supervises the information being disseminated by grantees and partners at curriculum and technology conferences across the state and nationally. Other dissemination efforts include establishing demonstration sites at each MTS project, reporting regularly on project progress to government leaders and the public, distributing research reports, and coordinating statewide promotions. As in all project activities, business and research partners chose to participate in these and other dissemination activities on an individual basis.

1.4. Organization

Every MTS project is led by a project management team, each varying slightly in composition to better serve the various project approaches to implementation. Generally the configuration consists of project director(s) with responsibility for overall project management and coordinators of research, curriculum support, and training. They are guided by local Advisory Councils made up of representatives of business and industry, research and teacher training institutions, community organizations, and other educators.

1.5. Diversity of sites

The six Model Technology School sites represent a diversity of numbers of schools and enrollment, ethnic composition, and administrative organization. The Alhambra complex of two schools (K-8 and 9-12) is administered by their elementary and high school districts with a common administration. The Cupertino-Fremont complex of three schools, (K-6, 7-8, & 9-12) involves two districts with separate administrations. Hueneme, joining MTS a year into implementation, involves one middle school, grades 6-8, an exception to the state-wide K-12 configuration. The remaining three complexes represent unified school districts. The Los Angeles complex with four schools, all on year-round schedules, are organized by grade levels of K-5, 6-8, and 9-12. The Sacramento complex of three schools serves grade levels of K-6, 7-8, and 9-12. The Monterey complex of four schools serves grade levels of K-5, 6-8, and 9-12. In the appendix to this chapter, an overview of the ethnic composition of the California Model Schools is given.

2. Organization of the Project: The Monterey perpective.

2.1. Monterey's objectives

Diversity does not stop at enrollment, ethnic composition, and administrative organization. Each of the six project sites is seeking to meet statewide project goals in their own way and with their own unique set of site-specific objectives. As a student-centered project, Monterey's primary objective is to nurture in its student participants those characteristics of the "proactive learner" (the "PAL"): risk-taking, questioning, the use of higher-order thinking skills, working effectively alone and in groups, and to increase self-efficacy. Other objectives for Monterey are to increase home/community-to-school connectivity, to establish site-based decision-making models, to establish student information management components for increased school office productivity, and to establish models for developing local business and industry partnerships.

2.2 Technology access

The diversity of the six California Model Technology Schools extends to the varied ways that technology access has been organized. The California Model Schools Equipment Configuration Matrix (Figure 1A-1E) best presents this diversity. The numerous hardware and peripherals available to project participants represent an effort by the project to investigate the impact of multiple technologies across a broad base. In Monterey alone, computer access ranges from classroom stand-alones to mini, satellite, and full labs, some of which are networked. The Monterey Project has also recently added laptops (notebooks) for continuous student access to study closely

California State
Department of Education
1990-91

Model Technology Schools Matrix

FIGURE ONE

		Alhambra School District					Cupertino-Fremont School Districts					Hueneme School District		Los Angeles Unified School District				Monterey Peninsula Unified School District			Sacramento Unified School District		
		Emery Park School (K-8)	Alhambra High School (9-12)	Garden Gate Elementary (K-5)	Kennedy Junior High (7-8)	Monta Vista High School (9-12)	Charles F. Blackstock (6-8)	Corona Avenue Elementary (K-5)	Loma Vista Avenue School (K-5)	Nimitz Junior High (6-8)	Bell High School (9-12)	Manzanita Elementary School (K-5)	Ord Terrace Elementary School (K-5)	Martin Luther King Middle School (6-8)	Monterey High School (9-12)	Edward Kemble Elementary (K-5)	C. M. Goethe Middle School (6-8)	Luther Burbank High (9-12)
Configuration Of Computers	Banks of Computers		✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓
	Banks of Computers, Hallways	✓																
	Computers on Carts	✓	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓	✓
	Integrated Learning Systems			✓			✓							✓		✓	✓	
	Labs, Networked	✓	✓	✓	✓	✓	✓							✓		✓[1]	✓	✓
	Labs, Not Networked		✓									✓	✓	✓	✓			
	Laptop Computers	✓	✓				✓								✓			
	Stand-Alone Computers	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓
	Teacher Workstations	✓	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓	✓
Major Computer Vendors	Apple	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
	IBM		✓				✓					✓	✓	✓	✓	✓	✓	✓
	Tandy		✓				✓	✓	✓						✓			
	Other						✓											
Networks - Configuration	Classroom			✓			✓	✓						✓	✓	✓		✓
	Lab	✓	✓	✓	✓	✓	✓							✓				✓
	School-Wide		✓	✓			✓									✓	✓	✓[4]
	Other	✓[3]		✓[3]	✓[3]	✓[3]		✓[2]	✓	✓[2]		✓[3]	✓[3]	✓[3]	✓[3]			

Notes:
[1] Information Center
[2] Technology Center
[3] School Office
[4] In process

FIGURE 1A

BEST COPY AVAILABLE

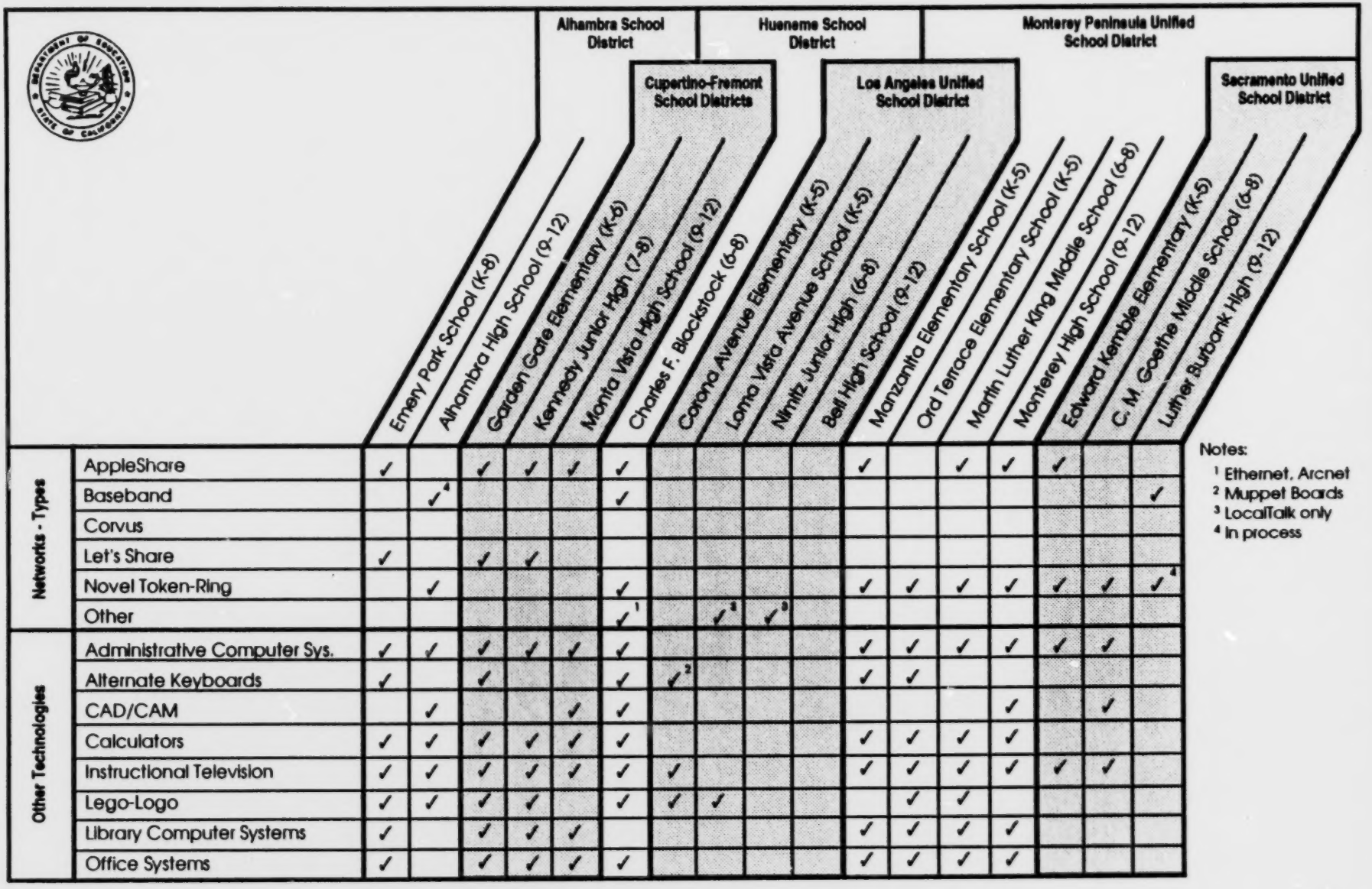

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FIGURE 1B

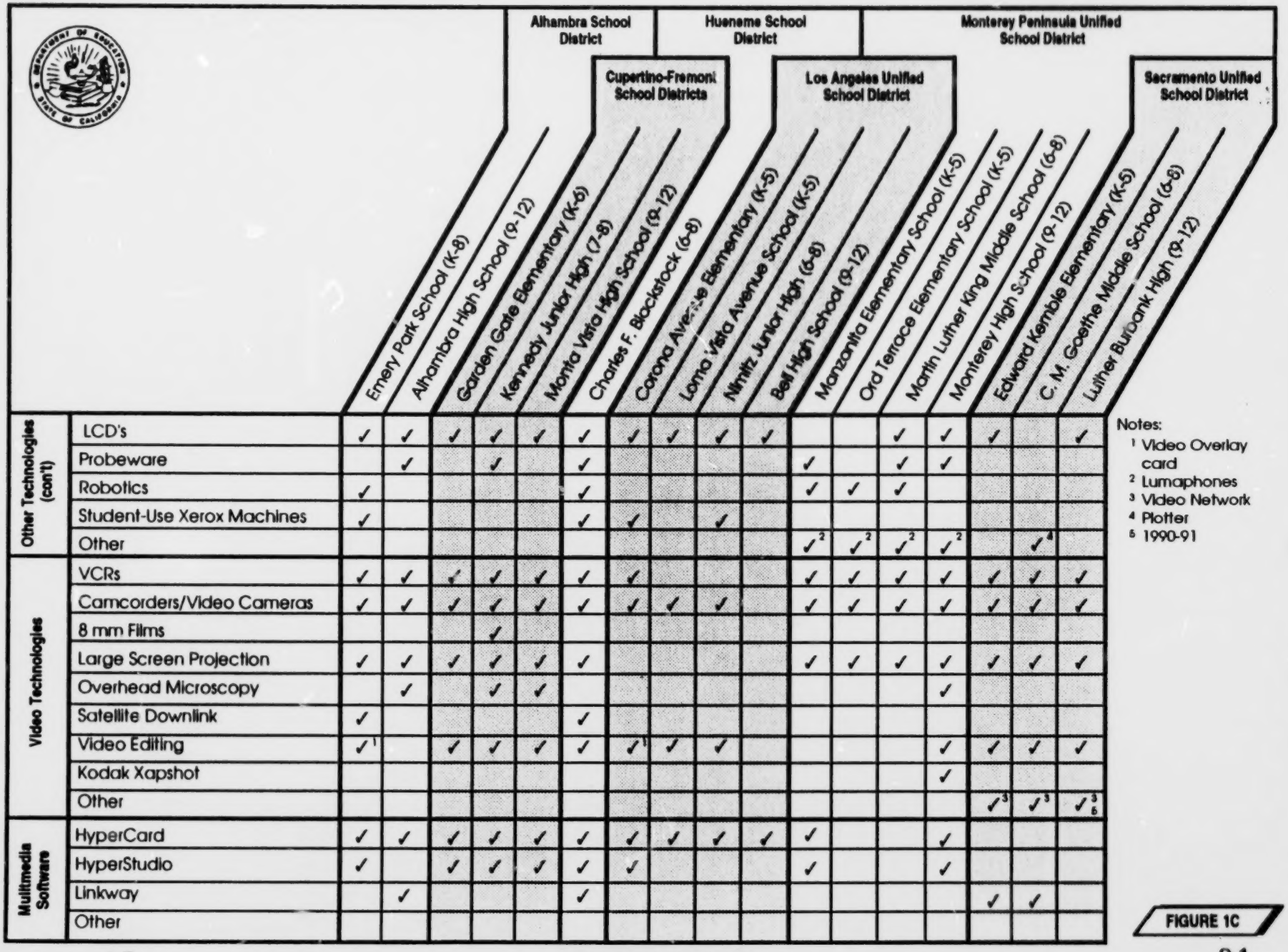

FIGURE 1C

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		Alhambra School District		Hueneme School District			Cupertino-Fremont School Districts		Los Angeles Unified School District				Monterey Peninsula Unified School District				Sacramento Unified School District		
		Emery Park School (K-8)	Alhambra High School (9-12)	Garden Gate Elementary (K-6)	Kennedy Junior High (7-8)	Monta Vista High School (9-12)	Charles F. Blackstock (6-8)	Corona Avenue Elementary (K-5)	Loma Vista Avenue School (K-5)	Nimitz Junior High (6-8)	Bell High School (9-12)	Manzanita Elementary School (K-5)	Ord Terrace Elementary School (K-5)	Martin Luther King Middle School (6-8)	Monterey High School (9-12)	Edward Kemble Elementary (K-5)	C. M. Goethe Middle School (6-8)	Luther Burbank High (9-12)
Multimedia Equipment	Laser Videodiscs	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	CD-ROM	✓	✓	✓	✓	✓	✓	✓				✓		✓	✓		✓	✓
	Digitizers	✓	✓		✓	✓	✓	✓	✓	✓				✓	✓			✓
	MacRecorder		✓		✓	✓	✓		✓	✓					✓			
	MIDI				✓	✓	✓					✓	✓		✓		✓	
	Scanners	✓	✓		✓	✓	✓		✓	✓					✓		✓	
	Other							✓[1]										
Telecommunications	AppleLink	✓		✓	✓	✓	✓	✓					✓		✓			
	CSUNet	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓			
	Dialog						✓					✓	✓	✓	✓			
	FrEdMail	✓						✓	✓	✓		✓	✓					
	National Geographic KidsNet	✓		✓								✓	✓			✓		
	Prodigy								✓			✓						
	Psi Net		✓															
	Local Bulletin Board	✓	✓				✓					✓	✓	✓	✓			✓
	Pac Bell Connection																	
	Other	✓[2]						✓[2]										

Notes:
[1] Screen Recorder
[2] NASA

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FIGURE 1D

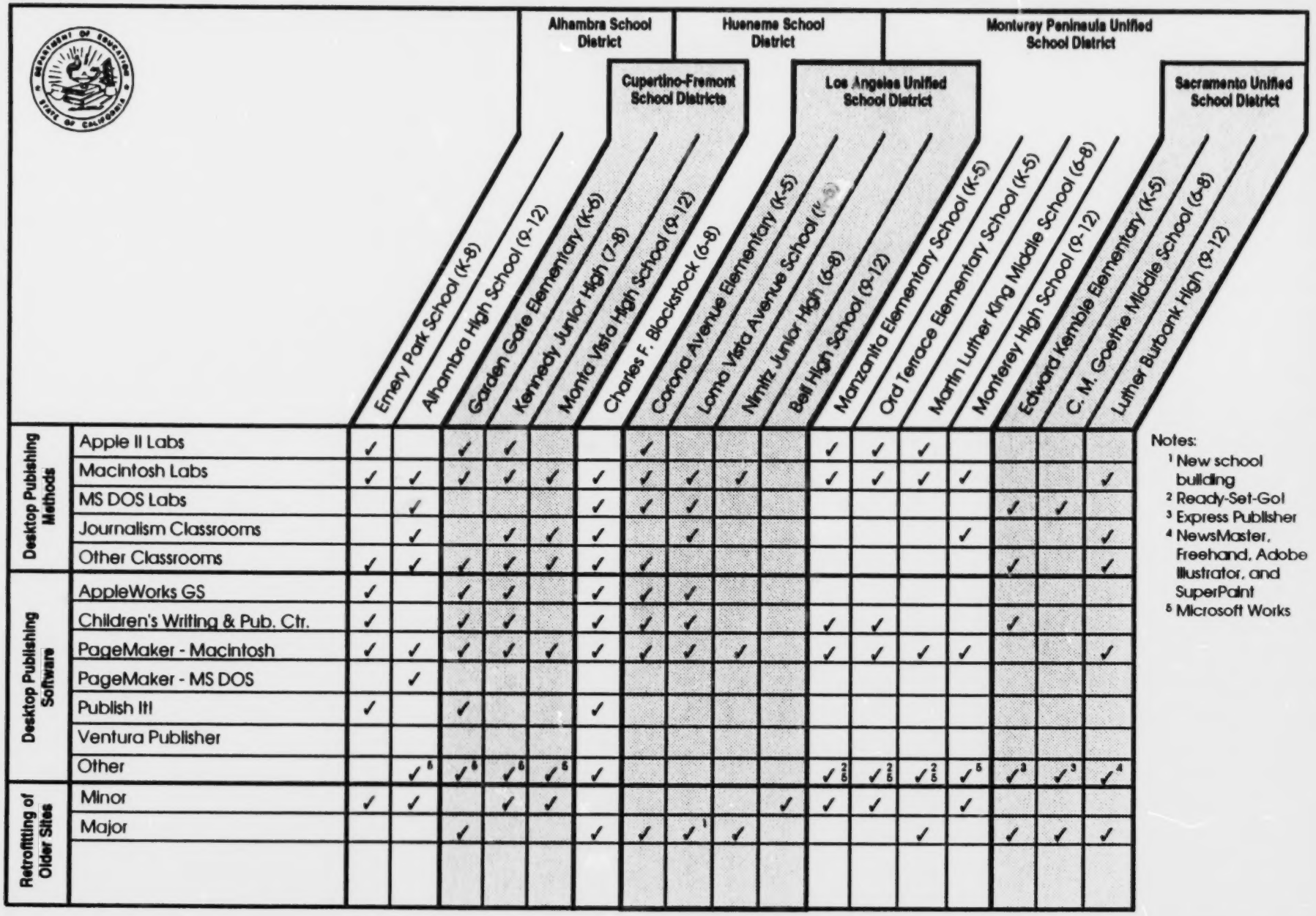

FIGURE 1E

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the effects on writing skills acquisition as well as student study skills and attitudes.

2.3. Staffing

A support staff manages each of the six projects, generally consisting of a project director, coordinators for curriculum and training, individual site support personnel, and an independent research and evaluation coordinator. It is interesting to note that the curriculum and training coordinators "joined forces" early in project implementation because their respective roles and functions overlap greatly; perhaps this is reflective of the notion that teacher inservice and support is a major component of successful curriculum alignment.

2.3.1. Strategy underlying Monterey's approach to staff support

Monterey, from the outset and by design, has maintained a relatively small support staff. The rationale was to gradually train and support a cadre of inhouse teachers-as-trainers. In this way assistance, support, and coaching would always be just a room or hallway away. (It would also best bridge the changes in support that are due to occur when state funding ends.) The concept provides for increased collegiality and site teambuilding and is one way to reduce isolation so typical in the teaching profession. To this end, the project initially had a full-time director, a curriculum coordinator, a half-time training coordinator, and a full-time classified instructional aide at one of the elementary schools. The director had been instrumental in the competitive grant writing process and previously had been the district technology resource specialist. The director has remained unchanged, but has recently received broadened district level responsibilities as the project goes into its dissemination phase. Furthermore, these responsibilities reflect the high priority that education technology holds within the district.

2.3.2. Training coordinator

The training coordinator had been the district's technology mentor teacher whose project established the vision for the MMTS project proposal during the grant formulation. This position began as half-time to enable on-going curriculum alignment and field-testing of instructional strategies in a classroom setting. The schedule lasted six months before the coordinator changed to a full-time position with the project. This was due to overwhelming demands for continued support and follow-up services once entry level training had been completed for the two elementary schools who were capitalized Year One. Parallel to changes in assignment for the director, the training coordinator has assumed assistant director responsibilities and will work in liaison with district personnel in the establishment of a new demonstration and training center, again reflective of the dissemination mode. Additional staff development support personnel will be added for the upcoming year to assist with district-wide training and dissemination efforts.

2.3.3. Curriculum coordinator

The curriculum coordinator had been a site-level administrator with broad technology experience to match strength in curriculum and instruction. This position was full time for the first two years of the project. In Year Three the curriculum coordinator became part-time as more and more of the curriculum development and alignment to state frameworks was undertaken by teachers and district staff as part of the institutionalization process.

2.3.4 Other team members

The research team was initially comprised of two individuals from a nearby institution of higher education. However, during the first year the research and evaluation effort was changed to a private research and evaluation contract to better meet the needs of the project research design. The team also grew from two to four researchers and a data analyst.

The principals at two of the three sites changed (three times at one and twice at another) due to district transfer policy or for personal reasons. The change in instructional leadership had an impact on project implementation: the role of the principal is key in a site-based decision-making model and a major leadership function is that of facilitation.

2.4. Decision making

2.4.1. Site-based

Each of the model sites developed their own unique model for decision-making. Monterey's model is best describe as a site-based, decision-making model. Principals and staff are involved in a systematic planning and development process whereby staff develop technology-based projects around their own ideas, ideas that address student needs and are reflective of their schools' plans. This specific process, unique to Monterey, creates an increased sense of ownership and commitment at the individual level. These activity-based projects, known as Classroom Intervention Plans (CIPs), Office Intervention Plans (OIPs) or Library Intervention Plans (LIPs), provide structure and focus for teachers and staff undertaking the implementation of education technology in instruction and in office management (Figure 2). Each CIP includes a description of the participating student group, subject matter emphasis, curriculum framework, and school plan objectives addressed. There are also clear objectives and activities with timelines that are planned for both students and teachers. With the assistance of the MTS Staff, procedures for evaluation and possible dissemination activities are built in. Each CIP also has a budget page and individualized staff development plan that address the needs of teachers implementing the specific CIP. The OIPs and LIPs follow this format closely with modifications directed toward target groups and specific plan objectives.

2.4.2. Site Teams

In order to coordinate the numerous CIPs and maintain site-wide articulation, school sites in Monterey established teacher-representative MTS Site Teams that act as "clearinghouses" for CIPs; these Site Teams also have budgetary discretion for site allocations of MTS monies and are the general decision-making bodies. These teams generally meet monthly. At the project level, the MTS Management Team meets quarterly to articulate project-wide activities. The Management Team is comprised of the MTS Support Staff, principals, and Site Team representatives and District-level liaison from curriculum and instruction.

3. Teacher Involvement, Inservice, and Support

3.1. Two major objectives

We must keep in mind two major MMTS objectives when considering teacher involvement, inservice, and support. The first is to make it possible for students to utilize skills and knowledge acquired from their education (content) combined with the tools now provided by technology to make independent, self-directed, self-regulated decisions that will optimize their ability to solve complex problems both in and outside the classroom. The approach to the use of technology in education envisioned in the MMTS project is therefore, defined as a "proactive student-centered approach."

The second objective is to design a site- or teacher-based planning and decision-making model. The philosophy of the MMTS approach is that teachers need to be making the important decisions. The validity of this approach was echoed in "Power On!", the 1988 report from the United States Congressional Office of Technology Assessment:

> Given the right circumstances, teachers could choose the appropriate way to reach their students. With the computer and other tools, the range of opportunities increases. But teachers have to be allowed to choose, willing to make choices, and qualified to implement their choices effectively.

3.2. Teacher involvement

Because of this site-based model, the MMTS teachers became involved in the project in ways unique to each of the four Monterey sites. During Year One, the two elementary schools were capitalized. Teachers at Manzanita and Ord Terrace Elementary Schools both chose to implement the project schoolwide; all personnel and specialists would participate in technology planning and implementation in some way. The Monterey Peninsula Unified School District made district initiated transfers available for those teachers who felt that technology integration activities were not among their professional priorities. To date, there have been no teachers electing this option except during Year Three when one elementary school changed to a year-round calendar. Prior utilization of technology at this level was limited to one VCR and television unit per building at both sites and four stand-alone computers in a special programmatic area at one site.

3.3. CIPS

During Year Two, the middle school Classroom Intervention Plans were developed by all teachers in selected departments and individuals in specialized areas such as Office Management and Special Education. Initially, participation included entire departments, but teachers self-selected for continued participation as the middle school entered its third year of project implementation. Generally, the Middle School staff had more experience with technology than at the elementary sites. There was one small computer-based reading lab (4 stations) in place as well as four stand-alone machines in remote classrooms used for basically drill and practice activities in math and some science simulations.

The high school was capitalized in two self-selected cadres over Years Three and Four of the Project and across all curriculum areas including physical education and the performing arts. By the time capitalization reached this level, the planning, development, and implementation process for the project had been finely tuned.

Three years of watching and waiting paid off twice over, especially in the area of identifying software appropriate to specific student needs as well as identifying ways to keep up with the fast pace of changes in the hardware industry. Technology background of high school participants varied widely from the novice to the expert from the first year teacher who had never turned a computer on, to the "tekkie" who just about knew it all.

3.4 Inservice Organization and delivery: From the general to the specific

3.4.1. Year One

Generally, the content of MMTS inservice opportunities over time reflect a trend away from a technology focus to a curriculum-applications and instructional-strategies focus, especially as institutionalization increased. During Year One of project implementation inservice activities fell into one of the following categories:

1. Operationally defining project concepts. (What exactly is a "proactive" learner?)
2. Planning site decision making models.
3. Establishing site curriculum committees.
4. Establishing student and organization or staff goals.

MONTEREY MODEL TECHNOLOGY SCHOOLS: Classroom Intervention Plan (CIP) Matrix

Manzanita Elementary School

This matrix provides a brief description of each MMTS application of educational technology, the level of emphasis for each MMTS "proactivity" and "curriculum" objective, and the type of "technology use"

Anticipated Impact on MMTS Student Objectives by each CIP
● = Major
◎ = Incidental
○ = None

CIP Project Title	Gr.	Pg.	Student Objectives: Proactivity: Internal Control	Critical Thinking	Self-Concept	Interpersonal	Interest-Attitude	Study Skills	Curriculum: Language Arts	Mathematics	Science	Hist-Soc. Sci.	Visual-Perf. Arts	Technology Use: Instructional TV	Computer	Audio Tape	Laser Disk	Camcorder	Calculator	Telecommunications
The Whole Cake (Using ITV to improve language skills and interest in good literature)	1		○	○	○	○	○	●	●	○	○	○	○	●	○	○	○	○	○	○
Lit Vid Kits (School/Home connection through literature related videos to improve language skills)	2		○	○	○	◎	●	○	●	○	○	○	○	●	○	○	○	○	○	○
Lights, Camera, Action! Literature Comes Alive Through Technology (Video taping of Reader's Theater)	3		○	○	○	○	●	○	●	○	○	○	○	○	○	○	○	○	●	○
Technology Across the Curriculum (Using computers and video in science and social studies)	4		○	●	○	●	◎	○	●	○	●	●	○	○	●	○	○	○	○	●
(Using technology to enhance organization, communication, and problem solving skills in science)	5		○	●	●	○	○	○	○	○	●	○	○	○	○	○	●	●	○	○

MONTEREY MODEL TECHNOLOGY SCHOOLS: Classroom Intervention Plan (CIP) Matrix

Ord Terrace School Page 1

This matrix provides a brief description of each MMTS application of educational technology, the level of emphasis for each MMTS "proactivity" and "curriculum" objective, and the type of "technology use"

Anticipated Impact on MMTS Student Objectives by each CIP
● = Major
◎ = Incidental
○ = None

CIP Project Title	Gr.	Pg.	Student Objectives: Proactivity: Internal Control	Critical Thinking	Self-Concept	Interpersonal	Interest-Attitude	Study Skills	Student Objectives: Curriculum: Language Arts	Mathematics	Science	Hist-Soc. Sci.	Visual-Perf. Arts	Technology Use: Instructional TV	Computer	Audio Tape	Laser Disk	Camcorder	Calculator	Telecommunications
Whole Language Approach to Literature (Using Writing to Read and ITV to teach language arts)	1		○	◎	○	○	●	○	●	○	○	○	○	●	○	○	○	○	○	○
Reading Mastery I and II Spelling Program (Using computers to teach Special Ed. spelling)	1/3		●	○	○	○	○	○	●	○	○	○	○	○	●	○	○	○	○	○
English Video Models for ESL Students	1/4		○	○	●	○	○	○	●	○	○	○	○	○	○	○	○	●	○	○
Problem Solving Strategies Enhanced with Technology	2		○	●	○	○	○	○	○	●	○	○	○	○	●	○	○	○	○	○
Be a Writer (Using computers and ITV to teach Language Arts)	3		○	●	○	○	○	○	●	○	○	○	○	●	●	○	○	○	○	○
California Writing Project with the Use of Computers (Word processing and cooperative learning for writing)	3		○	○	○	○	●	○	●	○	○	○	○	○	●	○	○	○	○	○
California Writing Project -- Integrating Technology and ITV	4		○	○	○	○	●	○	●	○	○	○	○	○	●	○	○	○	○	○
Applied Problem Solving (Using ITV and computers to improve problem solving skills.)	4		○	○	○	○	●	○	○	●	○	○	○	●	●	○	○	○	●	○
Using Calculators to Teach Math Skills	4		○	●	○	○	○	○	○	●	○	○	○	○	○	○	○	●	○	○
Problem Solving with ITV and Calculators	4/5		○	●	○	○	○	○	○	●	○	○	○	●	○	○	○	○	○	○
Creating Music on the Computer	4/5		○	●	○	○	○	○	○	○	○	○	●	○	●	○	○	○	○	○
California Writing Project with the Use of Computers	5		○	○	●	●	●	○	●	○	○	○	○	○	●	○	○	○	○	○
Logo Writer and Lego Logo (Enhancing proactive learning with Logo and Lego Logo activities)	5		○	●	○	○	○	○	○	●	○	○	○	○	●	○	○	○	○	○

MONTEREY MODEL TECHNOLOGY SCHOOLS: Classroom Intervention Plan (CIP) Matrix

Ord Terrace School Page 2

This matrix provides a brief description of each MMTS application of educational technology, the level of emphasis for each MMTS "proactivity" and "curriculum" objective, and the type of "technology use"

Anticipated Impact on MMTS Student Objectives by each CIP
● = Major
◎ = Incidental
○ = None

CIP Project Title	Gr.	Pg.	Student Objectives: Proactivity: Internal Control	Critical Thinking	Self-Concept	Interpersonal	Interest-Attitude	Study Skills	Curriculum: Language Arts	Mathematics	Science	Hist-Soc. Sci.	Visual-Perf. Arts	Technology Use: Instructional TV	Computer	Audio Tape	Laser Disk	Camcorder	Calculator	Telecommunications
Applied Problem Solving in Math (Using computers and ITV to improve problem solving skills)	5		○	◎	◎	○	●	○	○	●	○	○	○	●	●	○	○	○	●	○
The Rainbow Connection (Using computers and video to improve language arts skills and auto-dialer for school/home connection)	2		○	○	●	○	◎	◎	●	○	○	○	○	○	●	○	○	○	○	○
Word Wizardry (Using computers to assist special needs students in improving their spelling skills	1-3		●	○	◎	○	○	◎	●	○	○	○	○	○	●	○	○	○	○	○
Apple Story Books (Using computers, video, and audio tape to motivate students and improve oral and writing skills	K		○	●	◎	○	○	○	●	○	○	○	○	○	●	○	○	○	○	○
KOTO -- K - Ord Terrace Otters (Using camcorder/VCR and audio tape to improve oral and writing skills)	3		○	○	◎	○	●	○	●	○	○	◎	○	○	○	○	○	●	○	○
K-PLAY -- Kindergarten Pre-Logo Activities (Using EZ-Logo software to develop language arts and math skills)	K		◎	●	●	○	○	○	◎	●	○	○	○	○	●	○	○	○	○	○
(Using computers and video to improve reading speed, accuracy, comprehension, and inference skills for special needs students)	4-5		○	●	◎	○	○	○	●	○	○	○	○	○	●	○	○	○	○	○
Windows to Our World (Using instructional videos to increase students' awareness of other languages and cultures	K		○	○	●	○	○	○	●	○	○	○	○	●	○	○	○	○	○	○

MONTEREY MODEL TECHNOLOGY SCHOOLS: Classroom Intervention Plan (CIP) Matrix

King Middle School

This matrix provides a brief description of each MMTS application of educational technology, the level of emphasis for each MMTS "proactivity" and "curriculum" objective, and the type of "technology use"

Anticipated Impact on MMTS Student Objectives by each CIP
● = Major
◎ = Incidental
○ = None

CIP Project Title	Gr.	Pg.	Student Objectives: Proactivity: Internal Control	Critical Thinking	Self-Concept	Interpersonal	Interest-Attitude	Study Skills	Curriculum: Language Arts	Mathematics	Science	Hist-Soc. Sci	Visual-Perf. Arts	Technology Use: Instructional TV	Computer	Audio Tape	Laser Disk	Camcorder	Calculator	Telecommunications
Improvement of Writing skills (Paragraph development with word processing software)	6		○	○	○	○	●	○	●	○	○	○	○	○	●	○	○	○	○	○
Improvement of Writing Skills (Using computers to improve paragraph writing skills)	6		○	○	○	○	●	○	●	○	○	○	○	○	●	○	○	○	○	○
Teaching Estimation With Technology	6		○	○	○	○	●	○	○	●	○	○	○	○	●	○	○	○	○	○
Lego Logo with Middle School Math (Using Lego Logo to solve ratio and proportion problems)	6/7		○	●	○	○	○	○	○	●	○	○	○	○	●	○	○	○	○	○
Understanding Physical Science with Technology	6		○	●	○	○	○	○	○	○	●	○	○	●	○	○	○	○	○	○
Improvement of Writing (Composition development with word processing software)	7		●	○	○	○	○	○	●	○	○	○	○	○	●	○	○	○	○	○
Improvement of Writing (Composition development with word processing software)	7		●	○	○	○	○	○	●	○	○	○	○	○	●	○	○	○	○	○
Keying in Language Arts with Social Sciences (Developing reports with Video Encyclopedia)	7		○	○	○	○	○	●	○	○	○	●	○	○	○	○	●	○	○	○
Improvement in Problem Solving Through the Use of Technology	7		○	○	○	○	●	○	○	●	○	○	○	○	●	○	○	○	○	○
Moving Reports (Researching topics with Video Encyclopedia)	7		○	○	○	○	●	○	●	○	○	○	○	○	○	○	●	○	○	○
Developing Reading Skills Through CAI and Interactive Laser Discs	7		○	●	●	○	○	○	●	○	○	○	○	○	●	○	○	○	○	○
The News Report (Special Ed. Students use Video Encyclopedia and VCRs to research topics)	7/8		○	○	○	○	○	●	●	○	○	○	○	○	○	○	●	●	○	○
Using a Data Base to Improve Dietary Choices	7/8		○	○	○	○	●	○	○	○	●	○	○	○	●	○	○	○	○	○

King Middle School Page 2

This matrix provides a brief description of each MMTS application of educational technology, the level of emphasis for each MMTS "proactivity" and "curriculum" objective, and the type of "technology use"

Anticipated Impact on MMTS Student Objectives by each CIP
● = Major
○ = Incidental
○ = None

CIP Project Title	Gr.	Pg.	Student Objectives: Proactivity: Internal Control	Critical Thinking	Self-Concept	Interpersonal	Interest-Attitude	Study Skills	Curriculum: Language Arts	Mathematics	Science	Hist-Soc. Sci.	Visual-Perf. Arts	Technology Use: Instructional TV	Computer	Audio Tape	Laser Disk	Camcorder	Calculator	Telecommunications
Computer Assisted Instruction in Earth Science	8		○	○	◐	○	●	○	○	○	●	○	○	○	●	○	○	○	○	○
Video History (ITV for U. S. History Instruction)	8		○	○	○	○	●	○	○	○	○	●	○	●	○	○	○	○	○	○
Use of Computer Technology for Visual Presentation	8		○	●	○	○	○	○	○	●	○	○	○	○	●	○	○	○	○	○
Use of the Computer For Physical Science Review	8		○	○	○	○	●	○	○	○	●	○	○	○	●	○	○	○	○	○
Computer Write (Improvement of Writing Skills with word processing software)	8		○	○	●	○	○	○	●	○	○	○	○	○	●	○	○	○	○	○

MONTEREY MODEL TECHNOLOGY SCHOOLS: Classroom Intervention Plan (CIP) Matrix

Monterey High School Cadre I Page 1

This matrix provides a brief description of each MMTS application of educational technology, the level of emphasis for each MMTS "proactivity" and "curriculum" objective, and the type of "technology use"

Anticipated Impact on MMTS Student Objectives by each CIP
● = Major
◎ = Incidental
○ = None

CIP Project Title	Gr.	Pg.	Student Objectives: Proactivity: Internal Control	Critical Thinking	Self-Concept	Interpersonal	Interest-Attitude	Study Skills	Curriculum: Language Arts	Mathematics	Science	Hist-Soc. Sci.	Library Research	Foreign Lang.	Business Educ.	ESL	Technology Use: LCD Projector	ZAP SHOT Vid. Cam.	Instructional TV	Computer	Video Projector	Laser Disk	Camcorder	CD ROM Ency.	Telecommunications
A Technology Enhanced English Immersion Prog. for Potential English Proficient Students	9-12		○	○	○	○	●	○	○	○	○	○	○	○	○	●	○	○	○	○	○	○	●	○	○
Project Eureka (Use of technology in the library to improve report writing)	9-12		○	○	○	○	○	●	○	○	○	○	●	○	○	○	○	○	○	○	○	○	○	●	○
MacStar (Skills, Technology, and Resources for Post High School Planning Using The Macintosh)	9-12		◎	○	○	○	●	○	●	○	○	○	○	○	○	○	○	○	○	●	○	○	○	○	○
Passport Ninety (Using computers, laser disks and videos to increase attention span of spec. ed. students)	9-12		○	○	○	○	●	○	○	○	○	●	○	○	○	○	○	○	○	●	○	○	○	○	○
Technology Assisted Student Progress Feedback (Immediate feedback using gradebook software)	9-12		◎	○	○	○	●	○	○	○	○	○	○	●	○	○	○	○	○	●	○	○	○	○	○
Technology for Español (Using video and audio tapes to enhance teaching of Spanish)	10		◎	○	○	○	●	○	○	○	○	○	○	●	○	○	○	○	○	○	●	○	○	○	○
Write Right with Computers (Improving writing skills and attitudes with Macintosh computers)	9-12		○	○	○	○	●	○	●	○	○	○	○	○	○	○	○	○	○	●	○	○	○	○	○
Using video and audio tapes and computers to improve reading and writing	9-12		○	○	○	○	●	○	●	○	○	○	○	○	○	○	○	○	○	●	○	○	○	○	○
Videos for History	9		○	○	○	○	●	○	○	○	○	●	○	○	○	○	○	○	●	○	○	○	○	○	○
Increasing Student Involvement with use of Technology (Using LCD projector to teach programming)	9-12		○	○	○	○	●	○	○	●	○	○	○	○	○	●	●	○	○	●	○	○	○	○	○

Monterey High School Cadre I Page 2

This matrix provides a brief description of each MMTS application of educational technology, the level of emphasis for each MMTS "proactivity" and "curriculum" objective, and the type of "technology use"

Anticipated Impact on MMTS Student Objectives by each CIP
● = Major
◎ = Incidental
○ = None

CIP Project Title	Gr.	Pg.	Student Objectives: Proactivity: Internal Control	Critical Thinking	Self-Concept	Interpersonal	Interest-Attitude	Study Skills	Curriculum: Language Arts	Mathematics	Science	Hist-Soc. Sci.	Library Research	Foreign Lang.	Business Educ.	ESL	Technology Use: LCD Projector	ZAP SHOT Vid. Cam.	Instructional TV	Computer	Video Projector	Laser Disk	Camcorder	CD ROM Ency.	Telecommunications
Advanced Video Technology in the Classroom (Using video digitizer and laser printer for essays)	11-12		○	○	○	○	●	○	○	○	○	●	○	○	○	○	○	●	○	○	●	○	○	○	○
Art Resources through Technology (Using camcorder and VCR to demonstrate craft processes)	9-12		●	○	○	○	○	○	○	○	○	○	●	○	○	○	○	○	○	○	○	○	●	○	○
Studying Time with Technology (Using ITV and LCD projector to teach World history	9		○	◎	○	◎	●	○	○	○	○	●	○	○	○	○	○	○	●	○	○	○	○	○	○
(Using camcorders, VCR and video editor to produce videos to teach economics and civics)	12		◎	○	○	○	●	○	●	○	○	●	○	○	○	○	○	○	○	○	○	○	●	○	○
HyperCard/Multi-media Biology Projects (Using multi-media to teach biology concepts)	9-12		○	◎	○	◎	●	○	○	○	●	○	○	○	○	○	○	○	○	●	○	○	○	○	○
Video Impact on Physical Skills (Using camcorder, VCR and projector to improve physical skills)	9-12		○	○	◎	○	●	○	○	○	○	○	○	●	○	○	○	○	○	○	●	○	○	○	○
ESL Science with Pep (Using video, laser disks and computers in ESL science)	9-12		○	○	●	○	○	○	○	○	●	○	○	○	○	○	○	○	●	○	○	○	○	○	○

Monterey High School Cadre II Page 1

This matrix provides a brief description of each MMTS application of educational technology, the level of emphasis for each MMTS "proactivity" and "curriculum" objective, and the type of "technology use"

Anticipated Impact on MMTS Student Objectives by each CIP
● = Major
◎ = Incidental
○ = None

CIP Project Title	Gr.	Pg.	Student Objectives: Proactivity: Internal Control	Critical Thinking	Self-Concept	Interpersonal	Interest-Attitude	Study Skills	Student Objectives: Curriculum: Language Arts	Mathematics	Science	Hist-Soc. Sci.	Visual-Perf. Arts	Foreign Lang.	Industrial Arts	ESL	Technology Use: LCD Projector	ZAP SHOT Vid. Cam.	Instructional TV	Computer	Audio Tape	Laser Disk	Camcorder	CD ROM Ency.	Telecommunications
Use of Video to Promote Learning in Industrial Arts (Using videos and camcorder to assist students in wood and metal skills)	9-12		○	○	○	○	●	○	○	○	○	○	○	○	●	○	○	○	●	○	○	○	○	○	○
Communications Skills Improvement (Using camcorder, computers, video, and audio tapes to improve oral and written language skills)	9		○	○	●	○	○	○	●	○	○	○	○	○	○	○	○	○	○	○	○	○	●	○	○
Assessing and Exchanging Primary Sources Via Technology (Using videos from and telecomm. to increase foreign language proficiency	11-12		○	○	○	◎	●	○	○	○	○	○	○	○	●	○	○	○	○	○	○	○	○	○	●
Dogong (Using computer and video cameras to enhance demonstrations biology and physical science classes)	9-12		○	○	○	○	●	○	○	○	●	○	○	○	○	○	○	●	○	○	○	○	●	○	○
Writing Enhancement (Using word processing applications to improve writing skills and enhance self-esteem)	11-12		○	○	●	○	●	◎	●	○	○	○	○	○	○	○	○	○	●	○	○	○	○	○	○
Senior Pro Test (Using lap top computers to improve writing proficiency and develop more interest and confidence in writing)	12		○	○	○	○	●	◎	●	○	○	○	○	○	○	○	○	○	○	●	○	○	○	○	○
Academia, Art History through Example (Using technology to increase students' knowledge and understanding of art)	10-12		○	●	○	○	◎	○	○	○	○	○	●	○	○	○	○	○	●	◎	○	○	○	○	○
Team Videos (Using audio and video tapes, laser disc, and CD ROM courseware to expose works of art, music, and architecture to students)	11		○	○	○	○	●	○	●	○	○	○	○	○	○	○	○	○	●	○	○	●	○	○	○
Fit to Print (Using word processing software to improve writing skills and develop positive attitudes toward writing	9-12		○	○	○	○	●	○	●	○	○	○	○	○	○	○	○	○	○	●	○	○	○	○	○
Using lap top computers, camcorder, and LCD projector to improve the quality of students' essays in U.S. history classes)	11		○	●	○	○	○	○	●	○	○	○	○	○	○	○	○	○	○	●	○	○	○	○	○

MONTEREY MODEL TECHNOLOGY SCHOOLS: Classroom Intervention Plan (CIP) Matrix

Monterey High School Cadre II Page 2

This matrix provides a brief description of each MMTS application of educational technology, the level of emphasis for each MMTS "proactivity" and "curriculum" objective, and the type of "technology use"

Anticipated Impact on MMTS Student Objectives by each CIP
● = Major
◎ = Incidental
○ = None

CIP Project Title	Gr.	Pg.	Student Objectives: Proactivity: Internal Control	Critical Thinking	Self-Concept	Interpersonal	Interest-Attitude	Study Skills	Curriculum: Language Arts	Mathematics	Science	Hist-Soc. Sci.	Visual-Perf. Arts	Foreign Lang.	Industrial Arts	ESL	Technology Use: LCD Projector	ZAP SHOT Vid. Cam.	Instructional TV	Computer	Audio Tape	Laser Disk	Camcorder	CD ROM Ency.	Telecommunications
Technology to Improve Writing Skills (Using computer software, camcorder, video and audio tapes to improve writing)	9-12		○	○	○	○	○	●	●	○	○	○	○	○	○	○	○	○	○	●	○	○	○	○	○
Creative Musicianship (Using computer interfaced w/ electronic keyboard and drum machine to compose student's own music)	9-12		○	○	○	○	○	●	○	○	○	○	●	○	○	○	○	○	○	●	○	○	○	○	○
Lap for Cap (Using lap top computers, camcorder, and LCD projector to improve students' proficiency in writing)	9-12		○	○	○	○	●	○	●	○	○	○	○	○	○	○	○	○	○	●	○	○	○	○	○

5. Providing an overview of available technologies.

6. Providing resources and support for independent practice and experimentation. (See Figure 3)

3.4.2. Year Two

However, with the advent of the Classroom Intervention Plans during Year Two, staff development took on an all new meaning (see Figure 4), because each teacher or team of teachers developed personalized inservice and staff development plans specifically for their CIP. These CIPs are in various stages of development and implementation; they also are variant in number as well, as teachers combine efforts into team or grade level CIPs, or spin off and create new CIPs based on past successes, or as new teachers come on board (e.g., the development of video portfolio assessments spinning off from a CIP focusing on expressive language acquisition via Readers' Theatre). They range from kindergarten to 12th grade, in all curriculum areas with a mosaic of targeted student groups, student outcomes, and technology emphases (as seen in Figure 2). With their attendant, individualized staff development plans, they present a challenge to project personnel.

Project faculty at the three sites directed curriculum committees to plan and develop site-wide technology strands that were not inherent to any one CIP. These site-wide strands were written into each school plan and required specific staff development activities, follow-up, and support. Some teachers chose to become in-house teachers-as-trainers to help with the implementation.

As well as CIP-specific staff development, teachers needed time for initial activities most of which involved planning, previewing materials, as well as collaboration, practicing, and experimenting with new ideas. Some teachers who were more technologically experienced, were at the stage of curriculum development and strategies planning, extensive time consumers. An initial look at all the staff development needs revealed a degree of commonalty to a point that allowed clustering of some training activities. But in turn, even these sessions generated requests for presentor-based follow-up and support on a one-on-one basis. Generic staff development for individualized planning and CIP implementation didn't seem to work.

Teachers also began expressing a desire for support in their own classrooms with their own target groups and resources. As the CIP process unfolds, it is also becoming obvious that follow-up support and assistance need to address unique teaching styles, management systems, and personalities. There is also one specific need that these change agents have: some "one" person to listen to concerns, fears, stories of total failures, brags of successes, or just plain complaints. The provision of moral support within the historical isolation of classroom instruction during "risky instruction" is a high value item among MMTS participants.

3.5. SuperSubs

To meet the obvious individual staff development needs, the "SuperSub Service" was conceptualized and planned with project teachers (Matray, 1991). This service is a time- and cost-effective model for providing individualized staff development opportunities, follow-up and continuing assistance for their endeavors to integrate technology into their teaching.

3.5.1. Organization

Participating staff are released by assigned "SuperSubstitutes" who utilize computer teacher teaching stations and technology-based lessons aligned with district curriculum. The stations are comprised of a mobile cart with a computer, 27" monitor, VCR, and a basket of supplies to render the SuperSub totally self-contained. This allows teachers to sign up for customized assistance on a voluntary basis as they feel the need. It provides them with time during the workday and frees them from preparation of often diluted substitute lesson plans. Assistance is provided by project personnel, consultants, and district mentor teachers. The concept grew out of several brainstorming sessions with project teachers whose ideas are incorporated into the structure of the service. This early ownership is one of several reasons for the popularity of the service. Another note of interest is the fact that the program was so named by excited ten-year-olds who enjoy their sessions with the "SuperSubstitutes" to the extent that they actively encourage their teachers sign up for staff development sessions. In particular, the service:

1. Provides for weekly release time during the workday by a substitute who is assigned to the project for the entire year. During this time teachers can receive individualized, tailored inservice. The substitutes are early retiree employees of the school district.

2. Makes teacher-prepared substitute plans optional. The SuperSubstitutes who arrive at scheduled classrooms to release teachers are totally self-contained with teaching station, technology-based lessons appropriate for each grade level, and all necessary materials.

3. Provides lesson objectives that are in alignment with district curriculum and, based on problem-solving and critical-thinking skill development, address some of the major goals of the MMTS project. Currently, at the elementary level, the service has built its program around Sunburst Communications' "Memory: A First Step in Problem Solving and "Discrimination, Attributes, and Rules: A Second Step in Problem Solving." At the middle school, "LogoWriter" (Logo Computer Systems Inc.) is the basis for an independent project-based program supported by the SuperSub Service. (Here, however, the program is closely articulated with math department personnel and is often an extension of regular math instruction.)

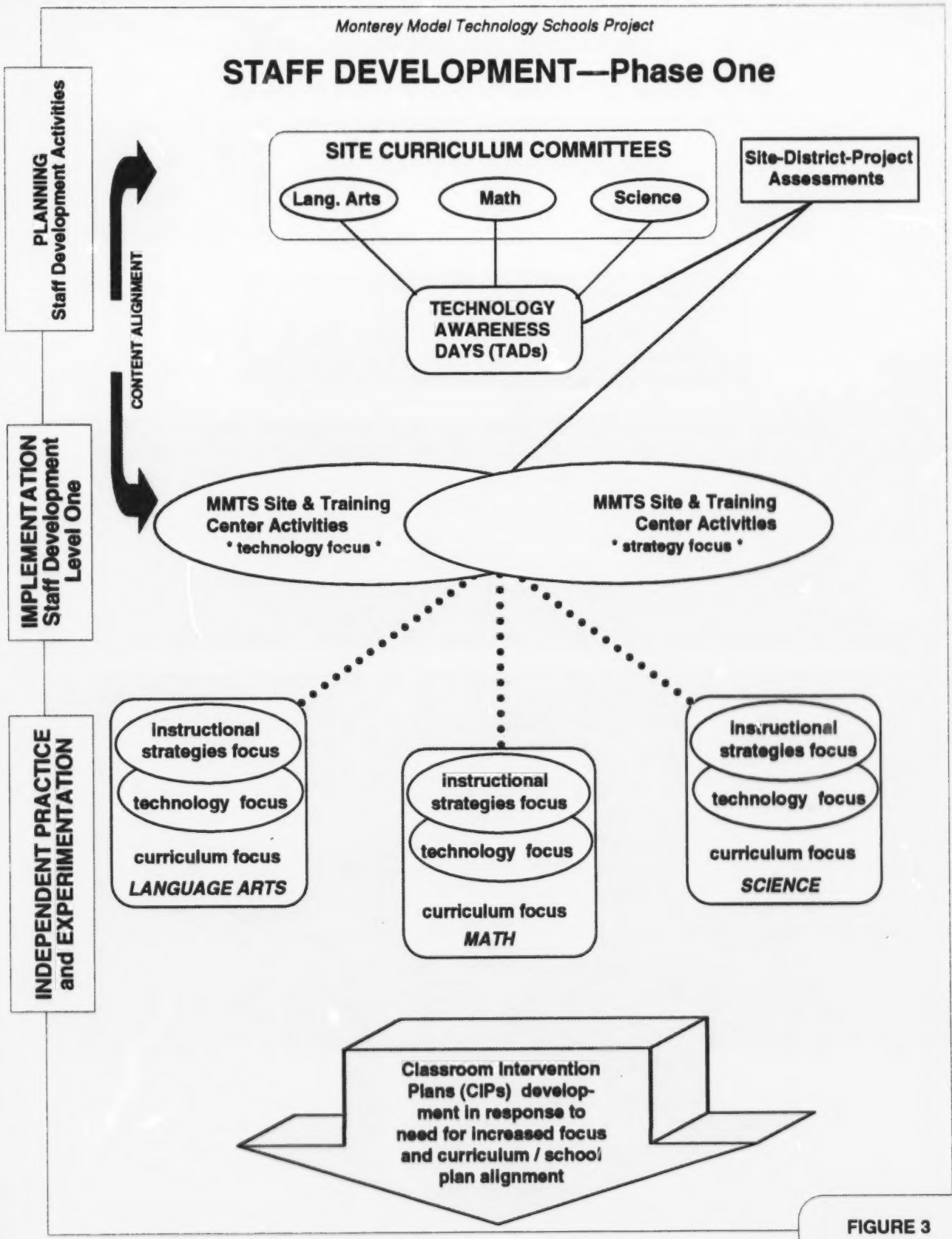

Monterey Model Technology Schools Project
STAFF DEVELOPMENT—Phase One
PLANNING
Staff Development Activities
IMPLEMENTATION
Staff Development
Level One
INDEPENDENT PRACTICE
and EXPERIMENTATION
CONTENT ALIGNMENT
SITE CURRICULUM COMMITTEES
Lang. Arts
Math
Science
Site-District-Project
Assessments
TECHNOLOGY
AWARENESS
DAYS (TADs)
MMTS Site & Training
Center Activities
* technology focus *
MMTS Site & Training
Center Activities
* strategy focus *
instructional
strategies focus
technology focus
curriculum focus
LANGUAGE ARTS
instructional
strategies focus
technology focus
curriculum focus
MATH
instructional
strategies focus
technology focus
curriculum focus
SCIENCE
Classroom Intervention
Plans (CIPs) develop-
ment in response to
need for increased focus
and curriculum / school
plan alignment

FIGURE 3

STAFF DEVELOPMENT—Phase Two

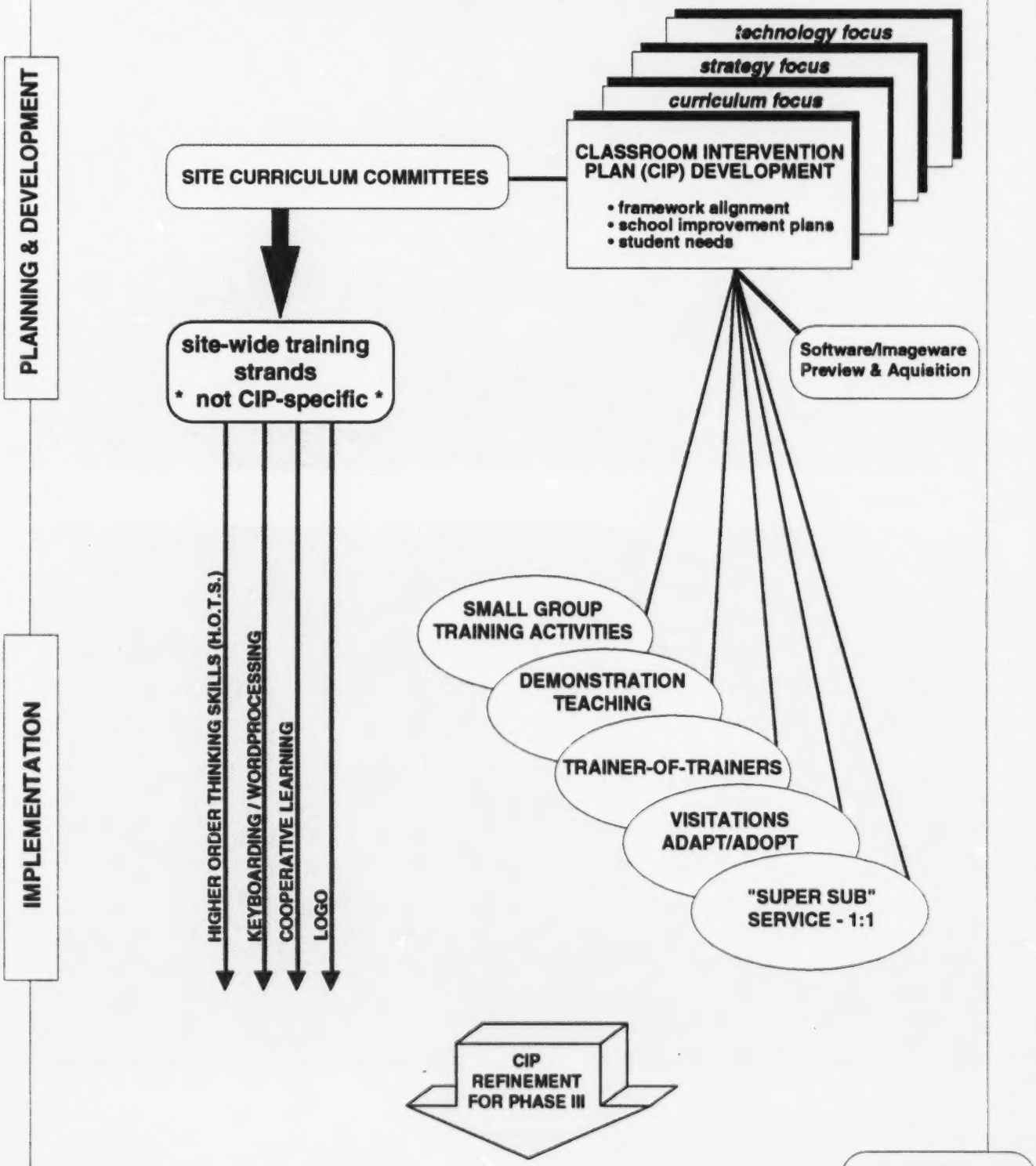


FIGURE 4

4. Provides participating teachers with time to meet with project staff, mentor teachers, or trainers-of-trainers for 45 minutes to an hour for individualized assistance. The content of each session is determined by teachers upon sign-up and often reflects individual CIP staff development plans.

5. Provides immediate feedback for participating teachers. Reports are left with participating teachers that briefly describe the lesson for that session as well as providing a follow-up activity. These reports make reference to pages in the appropriate documentation if further post-computer activities are desired by teachers. (All materials utilized by the SuperSubs are available for checkout at each site.) The SuperSub also includes general comments as to student behaviors if necessary.

6. Maintains site management records to insure continuity in the program. This is another facet that has added to the success of the program; it allows for the sequential delivery of content to participating classes.

7. Is voluntary. The session content, scheduled times, and periodicity are determined by the participating teachers and/or their CIP staff development plans. The structure of this program also facilitates use of in-house trainers-of-trainers to provide the requested assistance for their colleagues. With the growing number of talented staff whose own CIPs have made them experts and trainers in their own right, be it in Logo programming, readers theatre, or video editing, many has been the time when the SuperSub releases the classroom teacher and MMTS staff personnel releases the trainer.

3.5.2. Response to the service

Records show that utilization of the SuperSub service has doubled from year two to year three; full-day regular substitute use is down 67%; after school sessions [aka after school burnouts] are down 43%. Project dollars budgeted for regular substitutes in the past are now being spent by teachers for additional instructional materials or technology conference attendance. These statistics also show an increase in requests for time for:

1. Demonstration teaching
2. Collaboration for curriculum redevelopment
3. Observation and coaching sessions
4. Independent work on expansion of existing CIPs.

3.6. Year Four

As MMTS continues in its fourth year, teacher inservice and support has evolved into assistance for refinement and expansion of existing CIPs, development of new CIPs for new staff members, continued articulation of activities at the site and project levels (Figure 5), not to mention training for packaging and dissemination of promising practices. The articulation of office and library intervention plans with classroom plans is important as teachers expand their CIPs and require increased access and services that are inherent to the LIPs and OIPs. Support continues for the site-wide training strands although most needs are met by site "teachers as trainers." The need for support for preview and acquisition of new resources and on-going application seminars for those resources is another area of focus for staff development as staff work to keep up with the "cutting edge."

4. What's Happening?: The Monterey perspective of MTS

4.1. What's happening overall

In Monterey, the development and implementation of between 70 and 80 Classroom Intervention Plans, Grades K-12, has provided teachers, administrators, and office managers with "entry level" focuses to begin implementation of technology in their work. Figures 6A-6D provide site-specifics overviews on what is happening.

4.2. The CIP process in action

The development and validation of the CIP process at each of the Monterey MTS sites (Figure 7) offers a step-by-step, operationally defined and replicable model for teachers and administrators to effectively plan and utilize a wide variety of technologies to expand and enhance classroom/library instruction and school management. The model results in teacher/staff-developed plans that prescribe how technology might match, support and expand technology use to curriculum, objectives, and activities, as well as prescribing the needed staff development for implementation.

4.3. Extending CIP ideas

It is interesting to note, that in most cases project participants have extended computer and related technology uses beyond their original CIPs. In these CIP spin-offs, teachers are adopting/adapting ideas from their colleagues and expanding their software utilization to programs other than those noted in their individual plans. One example is when a middle school foreign language teacher tapped a colleague's expertise gained in a language arts CIP and subsequent use of GTE's World Classroom to enhance her Spanish curriculum and instruction. Also, school-wide endeavors are developing, based upon more focused CIP implementation. An example is found at one elementary site where the staff have developed a school-wide keyboarding and word processing scope and sequence. This involves the identification of grade-level expectations for skills development as well as identification of software for various grade levels and maintenance activities.

Monterey Model Technology Schools Project

STAFF DEVELOPMENT—Phase Three

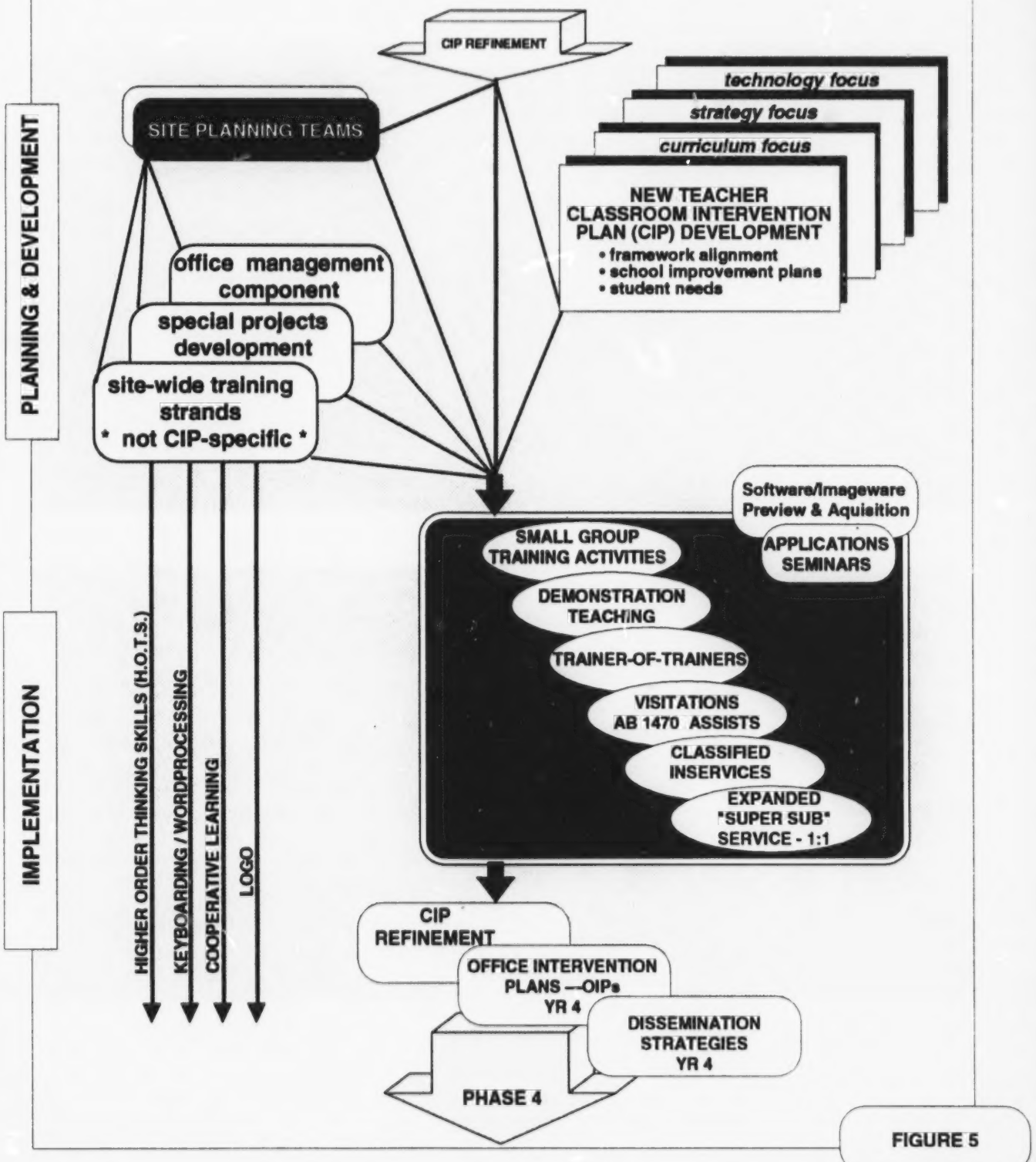


FIGURE 5

FIGURE 6A

MONTEREY MODEL TECHNOLOGY SCHOOLS
elementary schools

MANZANITA

■Site Description 1990-91

Manzanita Elementary School (K-5) is perched on a hill in Seaside, California overlooking Monterey Bay. The school, built in 1967, is modular in architecture with three open classroom buildings which house kindergarten, grades 1-2 and 3-5 respectively, a multi-purpose building, and a library/ office complex.

■Site Statistics

Participants:

Students	366
Certificated Personnel	23
Administrators	1
Non-certificated Personnel	11

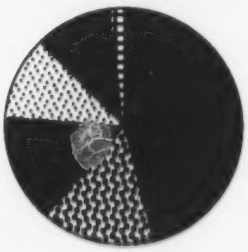
Economic Status:

AFDC	34.5%
Free/Reduced Lunch	53.0%

Specialized Programs:

Quality Education Program
English as a Second Language
SIP / Chapter One
4 Quarter/Single Track Year-round Program

Ethnic Composition:



BLACK	46.4%
ASIAN	12.4%
SPANISH	17.4%
PHILIPINO	11.0%
CAUCASIAN	11.0%
PACIFIC ISLANDER	1.7%

■Technology Configurations—highlights

Library

- IBM PS/2-60 networked to district LAN
- Circulation Plus catalog and inventory system
- Apple IIe teacher workstation
- ITV tape library
- ITV teaching station

Classroom

- ITV teaching stations in each classroom
- Laser disc player and imageware collection for intermediate student use
- 3 camcorders for school-wide use
- 3 mini-labs:
  15 Apple IIGS computers and printers / primary
  15 Apple IIGS computers and printers / intermediate
  6 IBM PC jrs. and printers / primary (Write To Read)
- 8 Apple IIGS stand-alone stations / 4 in each pod
- 8 Touchwindows / primary
- Weather station / intermediate
- Telecommunications / intermediate
- Calculators / class sets grades 1-5
- 30 portable units for keyboarding practice
- Teacher productivity station with laser printer

Administrative office:

- 4 IBM PS/2-30 computers on a Novelle network
- IBM PS/2 System 80 Fileserver
- SchoolMaster Student Information Management System
- Attendance Scanner
- PhoneMaster Public Notification System
- Macintosh SE 20 Desktop Publishing Center

■Representative Classroom Intervention Plans

- Science and Social Studies telecommunication units
- Language Arts: utilizing keyboarding and wordprocessing to enhance the writing process
- Visual Performing Arts—utilizing camcorders and Reader's Theater to enhance oral presentations, critiquing, reading and writing skills
- Language Arts: "into, through, and beyond" literature with instructional television

■Visitations

According to principal John Lamb, "visitors to Manzanita will see an active faculty working with administration and students to provide opportunities for proactive participation in lessons which utilize different aspects of technology. Demonstration lessons will give the visitor an overview of how technology is used across grade levels, from beginning to more advanced uses."

Contact the project office at (408) 899-1517 for visitation information and scheduling.

(FIGURE 6B)

MONTEREY MODEL TECHNOLOGY SCHOOLS
elementary schools

ORD TERRACE

■Site Description 1990-91

Ord Terrace Elementary School (K-5) is located near Fort Ord, a military installation in Seaside, California. The school was built in 1955 in the traditional "finger" architecture that includes five classroom wings, an office, and a multi-purpose with cafeteria complex. In 1962, nine classrooms were added to the facility.

■Site Statistics

Participants:

Students	660
Certificated Personnel	35
Administrators	2
Non-certificated Personnel	30

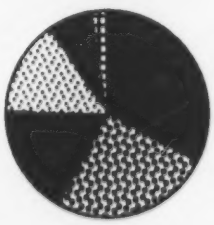
Economic Status:

AFDC	22.9%
Free/Reduced Lunch	46.3%

Specialized Programs:

Math / Science Magnet
Quality Education Program
Special Day Classes (1-5)
English as a Second Language
SIP / Chapter One
Writing to Read
Kids Are Special
Preparing for the Drug Free Years

Ethnic Composition:



CAUCASIAN	29.5%
BLACK	24.4%
SPANISH	22.8%
ASIAN	14.1%
PHILIPINO	6.6%
PACIFIC ISLANDER	2.5%
INDIAN	.3%

■Technology Configurations—highlights

Library

- IBM PS/2-60 networked to district LAN
- CIRCULATION PLUS
- Apple IIGS teacher workstations
- ITV video library
- 8mm camera & tripod / school-wide circulation
- ITV teaching station

Classroom

- 2 mini-labs:
  15 Apple IIGS computers and printers— "classroom lab"
  8 Apple IIGS computers and printers—magnet lab
  IBM Writing To Read lab
- ITV teaching stations (color monitors and VCRs) / each grade level
- Laser disc player and imageware library / intermediate
- 2 camcorders & tripod / school-wide circulation
- Apple IIGS stand-alone stations / one per classroom teacher
- Calculators / class sets grades 1-5
- Telecommunications / intermediate
- 30 portable units for keyboarding practice
- Teacher productivity station with laser printer
- Book publishing center for students

Administrative offices

- 3 IBM PS/2-30 computers on Novelle network
- IBM PS/2 System 80 Fileserver
- SchoolMaster Student Information Management System
- Attendance Scanner
- PhoneMaster Public Notification System
- Macintosh SE 20 for administrative uses

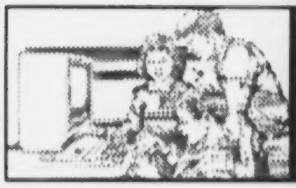
■ Representative Classroom Intervention Plans

- Using the computer for creative music compositions
- Developing higher order thinking skills with Lego/Logo
- Exploring mystery writing with ITV and computers
- Utilizing calculators and the computer to improve math skills in Special Day Classes
- Using camcorders to improve expressive language
- Weather-watch utilizing databases and telecommunications

■Visitations

On visitation days, anyone visiting this school will see, according to principal Linda Weesner, "not a 'Star Wars' presentation, but [instead] real teachers working with real students in real learning situations." Visitors will have an opportunity to observe utilization of technology in the classroom and hopefully come away with ideas for how they can begin to use it in their own classrooms and schools. No matter how simply one starts, it is possible to get a technology program "growing" in your school or classroom; visitors to Ord Terrace will come away with the seeds for beginning that growth.

FIGURE 6C



MONTEREY MODEL TECHNOLOGY SCHOOLS
king middle school

■Site Description 1990-91

Martin Luthur King Middle School is situated on a hillside overlooking the City of Seaside and the Monterey Bay. The school was constructed in 1965. The campus houses grades 6-8 in six major buildings plus an administration/counseling office area, a library/learning resources center, a multi-purpose/cafeteria facility, and a full gymnasium. Most of the student body lives in the neighborhood surrounding the school and few students have to be bused to the site.

■Site Statistics

Participants:

Students	624
Certificated Personnel	38
Adminstrators	2
Non-certificated Personnel	28

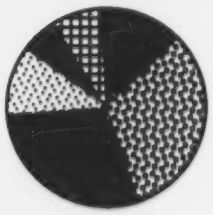
Economic Status:

AFDC	20%
Free/Reduced Lunch	18%

Specialized Programs:

Quality Education Program	Builder's Club
Human Relations Team	QUEST
Community Group Counseling	Morning Math
Student Assistance Team	
Student Exchange/COLORS	
Anita Archer Study Skills	
Youth Commission/City of Seaside	

Ethnic Composition:



SPANISH	14.0%
WHITE	32.2%
BLACK	32.7%
ASIAN	11.5%
INDIAN	.8%
PHILIPINO	7.7%
PACIFIC ISLANDER	1.1%

■Technology Configurations—highlights

Library

- IBM PS/2-60 networked to district LAN
- Circulation Plus cataloguing and inventory system
- Grolier's CD Rom Encyclopedia
- Video Encyclopedia of the 20th Century
- Dialog-on-line data retreival system
- 4 student work stations—Apple IIe
- 2 camcorders and 4 ITV units for school-wide use

Classroom

- computer labs
  30 networked Apple IIgs systems and printers for school-wide use
  30 networked computers systems—Jostens Integrated Learning System for math instruction
- satellite labs
  5 networked Apple IIe systems and printers in 4 Math classrooms
- mini lab of five Apple IIe computers and printers in Language Arts wing
- stand-alone systems on carts for school-wide use
- Hoffman Laser Learning Center for reading/writing instruction
- 2 telecommunication stations

Administrative offices

- 6 IBM PS/2 30 computers on a Novelle network
- IBM PS/2 System 80 Fileserver
- School Master Student Information Management System
- Attendance Scanner
- PhoneMaster Public Notification System
- Autodialer
- IBM XT networked to district data processing center

■Representative Classroom Intervention Plans

- Use of the Video Encyclopedia to develop social studies reports
- Composition organization, motivation development and task completion using word processing software in language arts
- Use of ITV, imageware, and software to promote under standing of physical science concepts
- Use of Lego/Logo activities to increase student problem-solving skills and capabilites
- Improvement of dietary choices by students using databases

■Visitations

Visitors will see a very clean campus and a lively middle school student body immersed in the use of technology in virtually every curriculum area. Principal Ron Breding states that "because of the students feeding from the two MMTS elementary sites with a high level of expertice in computer use, it has not been necessary to continue to offer a computer literacy course in the sixth grade." In addition to demonstrations, visitors will learn about how the school is being more effectively managed with the help of technology and how contact with the community has been increased.

FIGURE 6D

MONTEREY MODEL TECHNOLOGY SCHOOLS
monterey high school

■ Site Description 1990-91

Monterey High School is located on a hillside overlooking the Monterey Bay and serves students (9-12) from the peninsula cities of Marina, Seaside, Del Rey Oaks, Monterey, and Pebble Beach. The high school provides a comprehensive curriculum and a wide variety of intramural and extracurricular activities for its diverse and multi-ethnic student body. The school is one of the oldest high schools in California. It was constructed in 1904.

■ Site Statistics

Participants:

Students	1574
Certificated Personnel	84
Administrators	4
Non-certificated Personnel	25

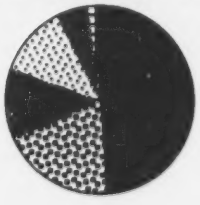
Economic Status:

AFDC	8%
Free/reduced lunch	14.9%

Specialized Programs:

Enlish As A Secondary Language Magnet
International Student Exchange
SCORE for College
College Partnership/UCSC
Model UN
CLOSE-UP
Constitutional Challenge
Academic Decathlon

Ethnic Composition:



CAUCASIAN	48.7%
SPANISH	19.4%
ASIAN	12.2%
BLACK	11.9%
PHILIPINO	5.7%
PACIFIC ISLANDER	1.6%
INDIAN	.5%

■ Technology Configurations—highlights

Administration

- IBM PC networked to district LAN
- SchoolMaster Student Information Management System
- IBM PC workstations for all administrators, counselors, and office personnel on Novelle network
- Autodialer

Classroom

- language arts lab of 18 Macintosh computers
- computer science/math lab of 15 IBM PC computers
- business education lab of 15 IBM PC/XT computers
- video stations for instruction in art classes
- stand-alone systems on carts throughout the campus
- model classrooms with ITV units, video viewers, computers, LCDs, in special education and language arts
- video production/editing lab
- Tandy laptop computers for student projects
- camcorders for teacher and student film production

Library

- IBM PS/2 80 networked to district LAN
- computerized circulation and inventory system
- on-line data retreival system/telecommunication center
- text on microfiche on CD ROM periodical review stations
- video viewing and editing stations
- computer-assisted instructional/learning stations
- desktop publishing stations
- Video Encyclopedia of the 20th Century (laser discs)
- Compton's Electronic Encyclopedia on CD Rom

■ Representative Classroom Intervention Plans

- Use of camcorder and video projector in physical ed
- Creative writing with laptop computers
- MacStar for post high school planning
- Social studies curriculum becomes interactive with technology for Special Education students
- Economics students produce video reports
- Advanced video production assignments
- Teacher generated video lessons for student use in Art
- Conversion of the library into a technological "discovery center"
- Use of commercial and teacher generated videos to increase student skills in industrial arts

■ Visitations

Principal Mae Johnson speaks with great enthusiam about entering the MMTS project, reflecting the attitude of the staff members who have elected to participate in the high school component. "We want to obtain and use technology which will have the greatest impact on our students. MHS students are not strangers to the world of technology, but everyone is excited about the possibilities for expanding and updating the equipment and materials via the Model Technology Schools Project."

The Classroom Intervention Plan(CIP) Process ...

One answer to a good question:

How can a teacher best focus his/er efforts of technology implementation at the classroom level?

The results of the first year qualitative evaluation strongly suggested a need for a clear definition of the specific expectations of the teachers participating in the Monterey Model Technology Schools Project (MMTS). This led to the development and implementation of project-based classroom intervention plans which provide a focus on instructional activities for students as well as identifying the training and support needed for the teachers to implement the plans. Teachers and/or teams of teachers define, develop, implement, evaluate, and refine specific CIPs for the use of educational technology and/or student-centered teaching strategies.

■ Elements of the Plan

- Students—student population anc'instructional needs
- Content—behavioral/curriculum/technology emphasis framework and school plan objectives alignment
- Intervention Plan Objectives—desired student outcomes
- Staff Development—prerequsite skills and needed inservice
- Activities Timeframe—sequence of instructional activities and planned implementation dates
- Practices or Products for Dissemination—potential products and/or practices
- Evaluation Plan—procedure for evaluating attainment of student objectives
- Resources—available materials/hardware needed
- Budget—items, cost, and budget for additional materials/hardware
- Commitment—commitment to reasonable effort and reasonable level of assistance

■ Elements of the Process—*collaborative, site-based planning*

- Develop CIP prototype
- Beta test and revise CIP (site by site)
- Attend "Awareness Days"—Technology/Curriculum/Instruction
- Preliminary Intervention Planning—set parameters for CIP
- Develop CIP with team and/or MTS staff member
- Site level articulation—(. do all the pieces fit together?)
- Budget revisions based upon site allocations
- District level articulation
- *On-going:* staff development➥implementation➥ evaluation➥revision➥
- Identify practices or products for dissemination
- Begin dissemination

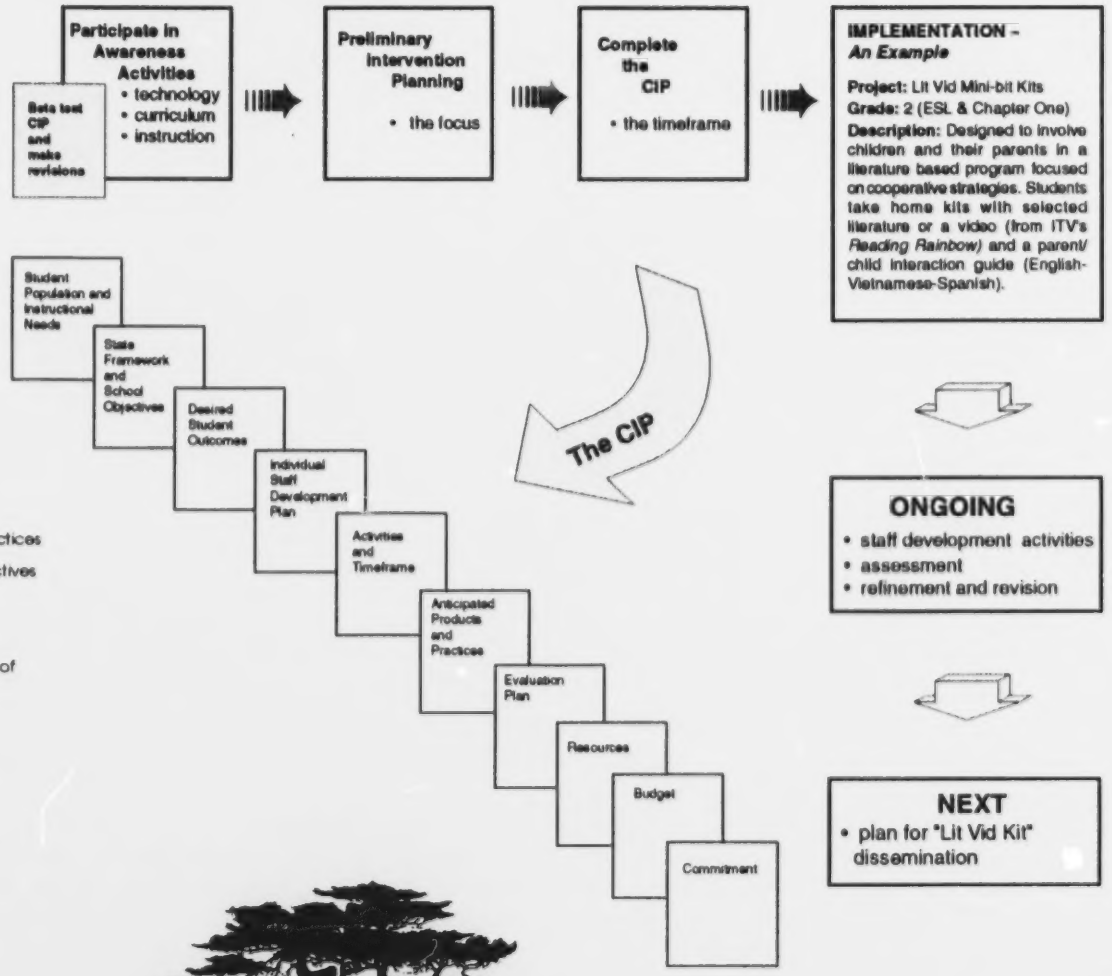

Participate in Awareness Activities
• technology
• curriculum
• instruction
Beta test CIP and make revisions
Preliminary Intervention Planning
• the focus
Complete the CIP
• the timeframe
IMPLEMENTATION –
An Example
Project: Lit Vid Mini-bit Kits
Grade: 2 (ESL & Chapter One)
Description: Designed to involve children and their parents in a literature based program focused on cooperative strategies. Students take home kits with selected literature or a video (from ITV's Reading Rainbow) and a parent/child interaction guide (English-Vietnamese-Spanish).
Student Population and Instructional Needs
State Framework and School Objectives
Desired Student Outcomes
Individual Staff Development Plan
Activities and Timeframe
Anticipated Products and Practices
Evaluation Plan
Resources
Budget
Commitment
The CIP
ONGOING
• staff development activities
• assessment
• refinement and revision
NEXT
• plan for "Lit Vid Kit" dissemination

FIGURE 7

4.4. Parent involvement

The impact of parent input and a Parent Advisory Team for MMTS is evident and worth special note when considering "what's happening." Among the multiple technologies in use at the Monterey sites, there is an emphasis on the use of selected programming from Instructional Television (ITV) for the home-to-school connection at the K-5 level. This emphasis supported one of MMTS's specific objectives (increasing home to school connections) and, more importantly, grew from parent recommendations—their rationale being that this technology supports a common link between home and school because both have access to or already use television and the video cassette recorder. Most parents felt that while they would never have computers at home, they do have this technology and could easily utilize it to participate in home extension activities with their children.

The project established a partnership with KQED, our regional public broadcasting station, and with their assistance began identifying and selecting programs that might help teachers better meet identified student needs in specific curriculum areas. In time, teachers found that the most cost-and time-effective way to access the programs was to build school site ITV libraries. ITV teaching stations have now been place, at teacher request, in all K-5 classrooms and in all departments (6-12) to support the use of in-house ITV libraries for instruction and the development of home-to-school technology activities. Some of these projects involve instructional applications built around selected children's literature and appropriate ITV programs that go home in Spanish, Vietnamese, or English depending upon the family's primary language. At school these stations consist of mobile carts with large screen monitors that interface with classroom computers and VHS video cassette recorders. For home use, ITV kits consist of sailcloth bags with a small, portable VCPs, if needed, selected literature, VHS tapes, parent/student activities, student journals, and all necessary supplies and materials.

4.5. Attention to cost-effectiveness

Attention to the issue of cost-effective implementation and cost benefits of technology intervention is ongoing as teachers and staff, in charge of their individual site budgets, continue to look for ways to stretch dollars, increase student access, and maximize impact on learning. One example finds a site choosing small battery-operated keyboards for keyboarding practice in order to open up the highly impacted lab schedule to increase time in the lab for research projects. In the area of office management, cost effectiveness of the system is evident from initial indications showing that automated calls to parents via the "auto-dialer" save staff time, increase the average number of school communications, and have a positive impact on parent attendance at school functions.

4.6. Funding patterns

As the project proceeds through its fourth year, a broad look can be taken at funding patterns, planning, and general effects to date pending summative reports from the research and evaluation team. With some variation over the first three project years, funding can be roughly broken out as follows:

Support Staff	32%
Equipment	25
R & E	20
Inservice *(use of teachers as trainers)*	11
Software/Imageware *(partnership support)*	8
District Indirect	6
Sub Release *(use of SuperSub Service)*	4

Although the total amount per year per project is $550,000, including the 10% district match, Monterey has "modulated" its technology integration by using the CIP planning process. This process results in projects that range in cost from $240 to $24,000 depending upon target group, objectives, outcomes, and technology(s) used. This makes technology use planning and implementation especially affordable to those schools with no special funding because adoption/adaptation can be undertaken in phases or in modules, depending upon the priorities or mission of a given institution.

5. What are the Effects of the Project? A Summary from the Monterey Perspective

5.1. Philosophy of CIP as a change process

The specific interventions brought about by the MMTS Project through the Classroom Intervention Plans differ from classroom to classroom and from school to school. Common to all is a change process, the CIP, that presupposes the belief in student as proactive learners, teachers as decision makers, and administrators and district staff working in a collegial and team atmosphere to achieve:

- A student-centered teaching philosophy
- A school-based planning and decision-making process
- An individualized staff-development program to meet varied professional development
- Focused interventions to meet student and instructional needs
- A link between technology implementation and state curriculum frameworks
- An integration of technology into curriculums and instruction

- An interface of varied technology in the classroom
- A use of multiple instructional-intervention strategies

5.2. Data collection on impact

Overall impact of the MMTS Project in the four school sites is being observed and documented by data collection from reports and surveys from teachers, staff, and students. The major instruments for data collection that have been used are:

- Student Impact Report Cards
- Structured Teacher Interviews
- Inventory of Teacher Reactions
- Teacher Reflections Reports
- MMTS Student Survey
- Visitor Information Survey
- Individual Portfolio Assessments
- CIP-specific Data Collection Instruments
- Standardized achievement tests
- Picture Inventory of Student Reactions

5.3. Representative findings

Findings are numerous; the following excerpts from the executive summary of the 1989-90 Research and Evaluation Report (Cradler, 1990) are only highlights:

- *Increased student proactivity and performance*
  District and state standardized achievement test scores and writing proficiency test data were analyzed. Spring scores showed relative increase at the secondary level and one elementary site while those at the second elementary site remain approximately at the same level. Writing proficiency increased at all sites. There was a tendency for achievement test scores to increase at MMTS sites.

  If MMTS is facilitating these increases, it is one of several possible contributing factors and almost impossible to isolate as a cause. It is well known that the implementation of a new program with special attention focused on it can stimulate changes in staff enthusiasm, emphasis on instructional outcomes, and administrative support, all factors that indirectly contribute to increased student achievement.

- *Improved student grades and effort related to specific MMTS interventions*
  The Student Impact Report Card is a procedure developed to assess the teacher perception of the influence or impact of the technology intervention on student performance. This procedure and rating is completed at report-card time. Teachers across all schools consistently indicated that their classroom interventions produced a moderate impact on the grades of the students in the sample. Elementary teachers rated the impact of their classroom interventions as between "moderate" and "high" while the secondary teachers rated theirs as slightly "below moderate." Since the elementary schools have been involved in the project longer than the secondary schools, it is expected that teachers might have perceived a greater impact of the interventions on their students. In addition elementary teachers are with the same students for a longer period of time and thus would be more aware of the specific influence of a particular instructional intervention on individual student performance and behavior.

- *Increased teacher commitment, interest, and confidence in the use of technology as a result of CIP specific evaluation plans*
  Each CIP's built-in evaluation plan is developed by the teacher or CIP team with assistance from the R&E staff to evaluate the outcome of each of the CIPs. Many CIPs are in varying stages of development and therefore cannot provided conclusive results, but are beginning to produce specific findings. Sources include teacher perceptions, observations of student work, analysis of student portfolios of CIP-related work, performance on teacher-made, CIP-specific tests. Some of the findings were:

  1. Using the word processor caused a reduction in student errors during composition;
  2. Computers and Instructional Television (ITV) increased enthusiasm for writing;
  3. ITV at school increased use of ITV at home;
  4. Cooperative learning and computers facilitated students learning from each other;
  5. Student self-confidence increased;
  6. Results from self-paced experiences increased application of technology, resulting in increased problem-solving abilities;
  7. Student motivation for writing increased when using the computer;

8. Spelling test scores increased;

9. Students were found to be motivated by ITV when it supported a thematic approach to instruction;

10. Calculators improved student problem-solving abilities;

11. Teacher productivity increased due to computers aiding in spell checking and editing for students;

12. Student attention span increased as a result of the LCD combined with the computer; and

13. Students using *HyperCard* and laserdiscs in science increased their science grades.

Teachers generally reported that their CIPs increased student achievement and academic performance. However, most CIP specific data are based on observation and perception. Objective measures were used when available. CIP findings at the high school tended to produce more content-specific and quantitative results while elementary level CIPs more often resulted in qualitative results. Secondary CIPs tended to be more subject matter specific.

- *Identification and dissemination of promising practices*
  Because Year Five will mark the year for dissemination of promising practices, project staff identified project-wide model, the site-based, decision-making model, the SuperSub Service, and the Advisory/Advocacy Team Model. These process pieces appear in a 4-part video kit highlighting MMTS and are, to date, being incorporated into an "adoption/adaptation" guide. In addition, Project staff and faculty identified 13 CIP-specific "products" for packaging for initial dissemination. Selection was site-based; the criteria was student impact, degree of implementation, replicability, innovation, and cost.

5.4. Dissemination and influence

The MMTS Project offers a model for technology-use planning and a variety of emerging and replicable projects and practices. Some of the MMTS research findings have gone beyond the school and district level and influenced recent California state education technology legislation (AB 1470). In addition, Monterey Peninsula Unified School District and the Monterey MTS Staff joined representatives from government, business, and industry in California's recent Educational Technology Summit to make recommendations for the new California State Master Plan for Education Technology. These activities and the promises of Year Five make the Monterey Perspective a valuable one for the statewide effort to define more clearly the role of technology in education.

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Appendix

California Model Schools —Ethnic Composition

District:	*Total Enrollment*	*Caucasian (%)*	*Black (%)*	*Hispanic (%)*	*Other(%)*
Alhambra	4015	649(16)	38(01)	1471(37)	1857(46)
Cupertino/ Fremont	2873	2097(73)	45(02)	136(05)	595(21)
Los Angeles	11066	556(05)	64(01)	10258(92)	188(02)
Monterey	3162	1406(44)	729(23)	302(10)	725(23)
Sacramento	2996	644(21)	1346(45)	599(20)	407(14)
TOTALS	24112	5352(22.2)	2222(9.2)	12766(53)	3772(15.6)

Apple Classrooms of Tomorrow: West High School

by Robert Howard and Jane Pratt[1]

1. Background, Goals, and Context of the Project

In August, 1986 Columbus Public Schools opened the doors of its first ACOT (Apple Classrooms of Tomorrow) classroom to thirty ninth-grade students at West High School. Today, ACOT serves 120 students in Grades 9 through 12 in four classrooms. ACOT is a result of the cooperative efforts of Apple Computer, Inc., Columbus Public Schools, The Ohio State University, and UCLA. The goal of the project is to study the effects on teaching and learning if teachers and students have total access to a technology-rich environment.

1.1. Beginning the project

The idea of ACOT began early in 1985 when Apple Computer, Inc. invited its regional offices to submit names of schools that had shown exemplary use of technology in their classrooms. These schools were then allowed to submit proposals to become part of the ACOT project. Columbus Public Schools was asked to write a proposal because it had developed an extensive community technology training program entitled Summer Tech that had local school, university, and business involvement. Summer Tech used these resources to purchase computers and offer a variety of technology classes to members of the community at very reasonable prices. After Summer Tech, the computers were given to the schools to be used by teachers and students in the classrooms. The four persons involved in the proposal-writing process were Dr. Howard Merriman, assistant superintendent; Mr. James Bailey, principal of West High School; Mrs. Jane Pratt, supervisor of the Department of Technology; and Mr. Robert Howard, computer science teacher at West High School. Columbus Public Schools was fortunate enough to be chosen as an ACOT site along with six other schools throughout the United States. Columbus West was the only high school in the project and the only school to write a proposal that included the use of Macintosh computers.

1.2. Philosophy

It is the belief of the ACOT staff that technology should be integrated naturally into the curriculum of the Columbus Public Schools' graded course of study. This is a document approved by the Columbus Board of Education and the State of Ohio Department of Education that states the student learning objectives for each curricular subject in every grade level, K-12. The philosophy written by the Columbus ACOT teachers specifically for their site supports that belief and is written as follows:

1.2.1. Philosophy

The ACOT program, in order to foster life-long learning, will create a computer saturated environment that encourages students' initiative, independence, and originality. The computer in the classroom as well as other high-tech equipment will be used as a tool to enhance the graded course of study in the areas of mathematics, science, language arts, social studies, and keyboarding.

To develop critical thinking skills, students will be encouraged to work on realistic situations and to formulate and answer their own questions. As a result, students will become gatherers, analyzers, and managers of information as they prepare for their future roles in society.

The instructional approach will be an interdisciplinary model, allowing learning from the various subject areas to be integrated wherever possible. Students will be encouraged and supported in pursuing their individual strong interest areas. Through exposure to computer applications in many fields, the students will develop a base for specialization during their educational experiences.

Through interaction, the ACOT community of learners will not only support each other in their learning, but also will seek to involve the staff and students at West High School as well as the community at large. The ACOT program will adapt to include other curricular areas as the program continues in its development.

1.3. West High School

ACOT is located on the third floor of West High School, which is a 60-plus-year-old brick building in Columbus, Ohio. The school accommodates approximately 1200 students of which 1/3 are minority students. The population of the school is primarily from lower middle-class, blue-collar families. The majority of students leaving West High School go directly from the classroom to the work force. Only about 20% of the West High students go on to some form of higher education (4-year college, 2-year college, vocational training) after graduation.

ACOT began with four teachers and 30 ninth-grade students in one classroom. Incoming freshmen students and their parents had been invited to an ACOT Information Night early in May of 1986 where they could learn about and apply to become part of the ACOT program. Out of approximately 100 applicants, 30 students were randomly selected through a lottery system that allowed equity in both race and gender. Students selected in the ninth grade can choose to continue in ACOT through all

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four years of high school. Each year another ninth grade class is added along with any replacements in the upper grades due to students moving out of the program. We now have four classrooms with nine teachers and approximately 120 students in the ACOT program.

1.4. Overview of the project

At the time of their selection into the program, the majority of students had no aspirations for continuing their education past the high school level. Now they discuss plans for continuing their education beyond high school and have confidence they will be successful in those pursuits. Every student in our first two graduating classes has been offered some type of college scholarship because of his or her technological expertise.

This program is also an experiment for teachers. Teachers are given additional team planning time to develop lessons that span material across the curriculum. The ACOT teachers had to learn how to make the best use of this opportunity by experimenting with several ideas and techniques before it became an integrated part of their teaching styles. The school day is divided into nine 42 minute periods. Students are in the ACOT complex five periods a day out of the nine. Class schedules are written so lessons can be presented to the students in a team-teaching atmosphere. English and social studies teachers develop lesson plans together for their instruction as do the mathematics and science teachers. The computer applications teacher works with all subject areas as his material lends support across the curriculum. This organization allows and encourages our teachers to coordinate their subject material and makes it more meaningful to the students. After the teachers became more comfortable with the idea of cooperative teaching, there was a natural transfer to bring the students in as a part of the teaching team. All the teachers have grown tremendously through this experience.

1.5 Facilities

Two of the four ACOT classrooms are designed to offer students and teachers access to technology tools that support collaborative group work and presentations. The other two classrooms are set up with a Macintosh on each student's desk for more individualized work. Since the ACOT students use most of the classrooms only in the morning, the space and equipment is shared with other West High School classes in the afternoon. ACOT staff and students have trained the other teachers and students to use the hardware and software available to them.

1.6 Research

Extensive research has been conducted in the ACOT program. The research is supported by Dr. David Dwyer, the ACOT Project Director at Apple Computer, Inc. and is coordinated through Dr. Rob Tierney at The Ohio State University and Dr. Eva Baker at UCLA. Through them, other educators conduct additional studies. For example, Dr. Jere Confrey from Cornell University has worked with the senior math and science teachers using software she is developing on the integration of physics and pre-calculus. In another project, Ms. Barbara Buckley from Stanford University worked with teachers and students on an interactive multimedia program in biology. Dr. Tierney's research staff is conducting studies which include the following:

1. Longitudinal case studies of how students' reading, writing, and thinking has been affected by high computer access during their four years in the ACOT setting.

2. A descriptive study to document ninth grade students' change during their initial year of high computer access in their four major subject classes.

3. A study that focused on students who exited the ACOT program and returned to the regular classrooms.

4. Investigations that compared students' learning (thinking processes, changes in knowledge, problem-solving) in a *HyperCard* multimedia environment with a non-*HyperCard* environment.

In the Longitudinal Case Studies, researchers followed six students over the course of their four years in ACOT and looked at certain patterns that evolved. These patterns included processing, self-evaluation, learning and thinking, task demands, view of text, and social development. The findings showed the students tend to look to the future in their thoughts about careers and how the use of computers impacts their lives. Socially, they feel more like a family in the ACOT program. They have become very helpful to each other when assistance is needed. All students have opportunities to present their ideas and projects, not only in front of their peers, but through many interactions outside the school setting. The students have become very independent. They have the confidence and knowledge that they can do things on their own to the point where many of the students have become experts in certain areas such as *HyperCard*, multimedia presentations, and graphics. The students have become productive computer users and can manage information, communicate through multimedia environments, use simulations, and experiment with different software and systems. They have become effective communicators orally, in writing, and through graphics and multimedia approaches. They have become problem solvers and have the ability to attack problems and construct ways to solve them on their own. They are experimenters because they have the opportunity to experiment with state-of-the-art hardware and software. Since students and teachers work together as collaborators, students have developed as team players, artists, and craftsmen.

The Ohio State University is beginning a study on alternative assessments in the classroom. The senior class is collecting materials for portfolios. The study is to see how the portfolio format can be developed in a high-tech educational environment. There are no findings at this time as the study has just begun.

Classroom strategies are observed through studies at UCLA that give a general view of an ACOT classroom at a particular point in time. The researchers observe how much time students and teachers spend with computers and what uses are made of the technology in the classroom.

2. Organization of the Project

2.1 Classroom organization

Currently, there are four adjacent classrooms as shown in Figure 1. Figures 2 and 3 depict how the two outer conventional rooms are much different than the two inner project rooms. Macintosh computers are networked together with the necessary LocalTalk and Ethernet cables. There are eight AppleTalk zones, each managed by a Macintosh IIcx file server with MacJanet networking software. Ethernet cabling is used to connect the eight servers with Liaison software providing a bridge between LocalTalk and Ethernet. Students may log onto the network and use many applications such as: *MacWrite, MacPaint, MacDraw, Geometry, Word, Works,* and *Excel.* Teachers can place assignments on the network to make them available to the students. Four of the servers have CD-ROM players attached for student access through the network.

We refer to the outer rooms (Figure 2) as conventional because student workstations are in rows. A presentation station serves as a teacher/student focal point in the room. The presentation workstation consists of a Macintosh, 45 megabyte removable cartridge drive, video laserdisc player, and a low-heat overhead projector with an LCD projection panel. Each student desk has a Macintosh SE with access to the network, ImageWriter, and LaserWriter printers. This setting is useful when each student needs his/her own computer for individual work.

Our two project rooms (Figure 3) have more powerful workstations with Mac IIx, Mac IIcx, and Mac portable computers. Most of these have 45 megabyte removable cartridge drives along with various scanners, CD-ROM players, MIDI keyboards, card readers, bar code readers, video laser disc players, LaserWriters, ImageWriters, and access to the network. These larger rooms allow space for students to work in groups and have access to all the equipment including VCRs and/or video cameras with which to construct large classroom projects. These workstations are suited for more intensive student projects. Several student projects are 5 to 60 megabyte in size, which require a minimum of 5 megabytes of RAM and a hard disk or cartridge drive for storage.

Obviously, technology plays an important role in all subject areas. Using the Macintosh as a tool to enhance the curriculum, students view the technology as a tool truck. Many tools may be needed to complete a job. Some tools are used more than others, but each tool is best fitted for certain tasks.

3. Teacher Involvement, Inservice, and Support

3.1. Selection of staff

The key to having a successful plan is to have teachers committed to the program and excited about the prospect of using new technology in their classrooms. The staff was chosen because of its interest in this project and its willingness to commit the time and energy needed to select and/or design software that will best meet the needs of students in each subject area. Another key ingredient is the support shown by the Columbus Public Schools administrators in providing flexibility in the teachers' schedules, which allows team planning periods every afternoon. The team planning periods are necessary to implement the interdisciplinary approach to the program. During the team planning time, teachers meet weekly to discuss new opportunities and/or problems encountered during the week and to schedule the different classrooms that meet their specific needs. This meeting is facilitated by the site coordinator. The teachers also meet monthly under the direction of the district coordinator to develop in-depth, long-range planning and interdisciplinary strategies for upcoming curricular units. Because course material is integrated and team taught, much time, planning, and coordination is required.

The teachers in this program were not necessarily chosen for their technical expertise. They were chosen because of their willingness to try new and innovative ideas in their classrooms. The teachers also had demonstrated certain qualities beyond technology that are valuable to the program. The four teachers who have been in the ACOT program since the beginning knew they would be learning all this new technology along with the students. At the same time, they would be creating lessons that integrate the use of computers in each curricular area within the graded course of study for ninth- and tenth-grade students. All this was new, and there were no guidelines to follow, which made these teachers true pioneers in the field. The teachers who joined the ACOT program in the second and third years had to develop lessons integrating computers for the eleventh- and twelfth-grade students, but they had an added challenge. As they were creating their teaching units, they were learning the hardware and software the students had already mastered. It was definitely a challenge and took a special type of teacher to be willing to do it.

West High School Apple Classrooms of Tomorrow

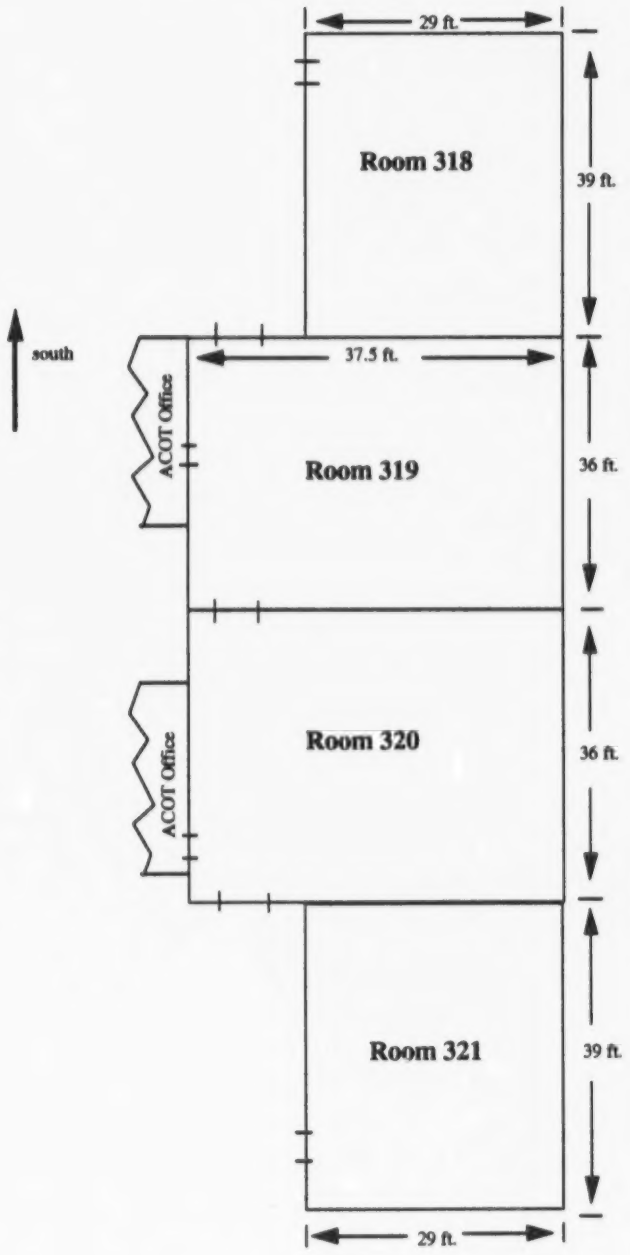
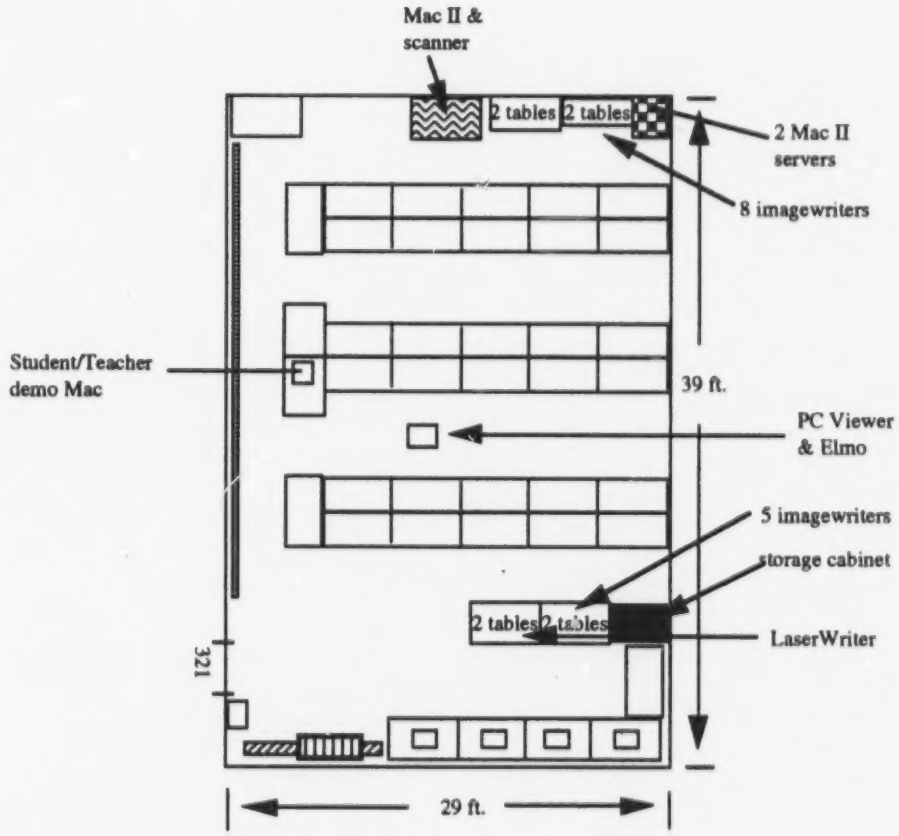


Figure 1

Rooms 318 & 321



Scale: 1 cm = 4 ft.

Figure 2

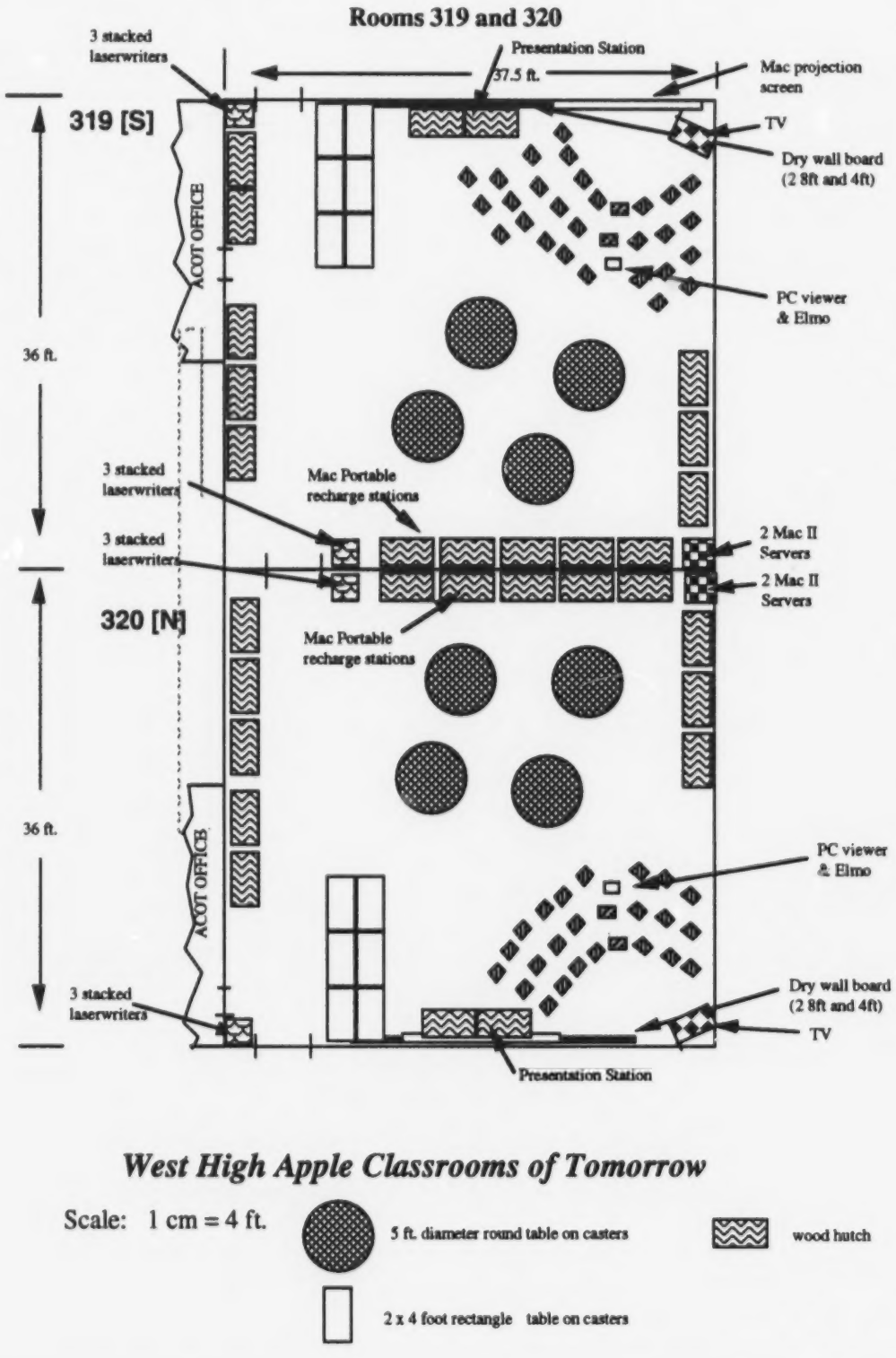

Rooms 319 and 320
3 stacked laserwriters
Presentation Station
37.5 ft.
Mac projection screen
319 [S]
TV
Dry wall board (2 8ft and 4ft)
ACOT OFFICE
PC viewer & Elmo
36 ft.
3 stacked laserwriters
Mac Portable recharge stations
3 stacked laserwriters
2 Mac II Servers
2 Mac II Servers
320 [N]
Mac Portable recharge stations
36 ft.
ACOT OFFICE
PC viewer & Elmo
3 stacked laserwriters
Dry wall board (2 8ft and 4ft)
TV
Presentation Station
West High Apple Classrooms of Tomorrow
Scale: 1 cm = 4 ft.
5 ft. diameter round table on casters
wood hutch
2 x 4 foot rectangle table on casters

Figure 3

3.2 Tasks of teaching staff

A description of the teaching staff is as follows:

- *Site Coordinator*
  Robert Howard came from West High School and was initially the most technologically advanced of all the teachers. He began as the mathematics teacher during the first year of ACOT. The second year he was made Site Coordinator and continues in that position today. He teaches the Technology/ Computer Applications courses, maintains the equipment, manages the network, and handles the visitation schedule.

- *English Teacher 1*
  Sheila Cantlebary received all her previous experience from middle school. She knew very little about computers but had expertise in team teaching and was well known for her willingness to try out new techniques and strategies in her classroom. Sheila is one of the original teachers in the ACOT program.

- *English Teacher 2*
  Sue Misiak came from West High School where she had been the English Department Chairperson. She is also known for her communications expertise and hosts a CPS radio talk show. Her use of computers before coming into ACOT was limited. Sue joined the program in the third year.

- *Social Studies Teachers 1 & 2*
  Both Richard Tracy and Dwayne Marshall came from a middle school background where they participated in team teaching and cross-curricular planning. Neither had any computer experience. Richard has been with ACOT since the first year, and Dwayne joined the program in the third year.

- *Mathematics Teacher 1*
  Paula Fistick joined ACOT in the second year when Bob became the site coordinator/applications teacher. Paula was already a teacher at West High School. Her experience with computers was limited, but she was well known for her enthusiastic approach to students and to mathematics instruction.

- *Mathematics Teacher 2*
  Carolyn Kennedy came to ACOT in the third year from an alternative high school where she had developed many strategies on individualized learning. She had some experience with computers and has developed many activities incorporating the use of spreadsheets into teaching algebra.

- *Science Teacher 1*
  Barry Stebbins had taught in the vocational program at West High School and is one of the original ACOT teachers. He is a self-taught computer user and a leader in developing new strategies in the classroom. He has become one of the nation's leading experts on *HyperCard* and in the creation of innovative applications of technology in science teaching.

- *Science Teacher 2*
  John Hopper's background was in research in industry and at the university level before coming to ACOT. He had some computer experience but none on the Macintosh. He joined us in the third year and is in the process of developing important communication links between the scientific community and the high school classroom.

3.3. Support personnel

- *Supervisor*
  Jane Pratt is the Supervisor of the Department of Instructional Technology for Columbus Public Schools and has been with the program from the beginning. Her ideas helped to shape the initial ACOT program and continue to lead its development for the future.

- *Art Support*
  Dr. Tim Best is a media specialist with the Columbus Public Schools and has put in countless hours on the artistic design of projects and presentations developed by students and teachers.

- *Music Support*
  Dr. Robert Carpenter meets with the students twice weekly to teach them to incorporate the use of the MIDI in student and teacher-designed projects and presentations.

- *Administrative Support*
  James Bailey, principal of West High School, has given his whole-hearted support to the ACOT program and has allowed teachers the flexibility in their schedules that helps make it successful.

Apple Computer, Inc. has not only provided all the equipment for the ACOT classrooms but has also provided intensive training for the teachers in the program. Teachers who have been added to the program receive training both from Apple Computer, Inc. and from Columbus Public Schools special instruction provided by Robert Howard, the site coordinator. Apple Computer, Inc.'s commitment to training continues each summer at the ACOT Summer Institute, which encourages all the ACOT teachers and support staff to learn about newly developed technology, current learning theories, and new curriculum ideas. The teachers themselves have become a major source of information, and as they come up with

new instructional methods that use technology, the ACOT staff gives them the necessary consultants and training they need to implement and evaluate their ideas.

4. What is Happening?

4.1. Types of activities

Technology is used to enhance the curriculum, not replace the curriculum. The classroom complex provides an environment blending technology, collaboration, interdisciplinary team teaching, problem solving, individual projects, community outreach, and assessment. The focus is on using technology as a tool. Written reports are generated with word processing and are often supported with graphics and charts. *Pagemaker* might be used for layout of the final report. Databases and spreadsheets can be used to enhance critical thinking skills as students work toward solutions to problems presented in various subject areas including vocabulary, geography, statistics, science, geometry, and algebra.

4.2 Types of software

Students work with about 50 different software applications. The programs used daily are *HyperCard, Microsoft Excel, Microsoft Works, Pagemaker, MacPaint, MacWrite, MacDraw,* Brøderbund *Geometry,* and the network workstation disk MacJanet. Just as a pencil is not considered to be subject specific, students do not consider the productivity software as subject specific. Students' use of the technology is an adult approach. They are excited about using the technology because they can be more productive in less time. When one is comfortable with the technology three possibilities can happen: (1) the same amount of work can be produced in less time, (2) more work can be produced in the same amount of time, or (3) more work can be produced in more time. We have observed most students fitting in the third category! Students want to continually revise, improve, and add graphics to their written reports, as well as electronic presentation reports. ACOT is using a knowledge-contructivist approach to achieve many important objectives. This approach allows students the freedom to work on given projects and to create their own solutions to attain a goal.

4.3. Transfer to the community

4.3.1. Kiwanis' activities

Technology provides a common bond to the public schools and the business community. Many interdisciplinary and real-world problem solving experiences have occurred and are continuing to occur. In September 1988, the technology/computer applications teacher was asked to make a presentation at the Hilltop Kiwanis Club weekly luncheon meeting. A brief explanation of ACOT was followed by a demonstration, which illustrated the text, graphics, and art capabilities of the Macintosh to the Club.

Kiwanis members asked if the ACOT class would be interested in producing the annual Kiwanis Christmas newspaper. Approximately 13,000 copies are sold and distributed in the school community each December. The class accepted the project, and this was the beginning of a wonderful relationship between the ACOT students and local community business leaders that has proven to be of mutual benefit.

All the projects the students completed for the Hilltop Kiwanis Club truly exemplify knowledge-construction in the classroom for both the students and the teacher. Students have completed the following projects for the Kiwanis club: a 40-page 11.5" by 14.5" 1989 color newspaper and the expanded 48-page 1990 color newspaper, a database of 500 potential advertisers, a database of the Kiwanis membership (91 members of local community business leaders), a promotional letter on letterhead sent to all potential advertisers, an advertisement order form sheet, a membership brochure, a pocket size membership directory, several promotional flyers, individually printed invoices to the advertisers inserted into matching window envelopes, and a 30-page Kiwanis 45-Year Celebration History booklet. From the database, students generated various printed weekly reports for the club for accounting purposes with current totals. Reports were sorted alphabetically by Kiwanian, alphabetically by advertiser, and by invoice number. Several sets of mail labels were also printed for various mailings.

4.3.2. Further description of Kiwanis' activities

The first lesson gave students an overview of the tasks to be undertaken, and a possible business environment structure was suggested to complete those tasks. Students chose their positions of responsibility and their work partners within this structure. The sincere acceptance of responsibility was demonstrated in the amount of effort exerted by the students. Collaborative learning, problem solving, and reflection were demonstrated during this eight-day activity. The student directors and supervisors worked hard to assist their departments and assure the consistency of database design.

For example, after some students had entered a few names and addresses they realized that some were four-line addresses and some were three line. They asked their supervisor what to do, other supervisors were consulted, and finally the director became involved. A solution in the database design was agreed upon, and the revised database design was channeled back down through the ranks. Supervisors distributed and collected materials and disks every day, made backups and reports to the directors who proofread names, addresses, and phone numbers. Student directors and supervisors also provided assistance where needed to assure the finished product was perfectly correct. It was an amazing and very impressive phenomena with these students. This wild idea was really going to work. When about eight of the business people came to greet the class and watch them, they commented

that the students showed great responsibility and the class was fantastic. This class did not resemble in any way what a class looked like ten years ago, but looked more like an information management business in action!

On some days, students met in four Departmental Groups. Departmental Groups meant dividing the students up into departments of advertising/logo, photo/art, copy, and supervisors of the layout departments. On other days, the students divided up into four Section Groups. The newspaper was divided into four sections with the 48 pages divided equally among the four groups. If students had not taken real responsibility with this project, it would have been impossible for the teacher to complete the layout after school. The students realized this was a project that needed their complete cooperation, and they were equal to the task. For several days the editors directed the class. They stood up front and used the dry marker boards to illustrate and coordinate class discussions on decisions that needed to be made regarding management of advertisements, logos, photos, art, and proofreading.

4.4 Student assessment

4.4.1. Strategies and student response

Student assessment is difficult in a project such as this. Students were required to turn in a journal containing a database of items they had been responsible for and had completed. The nine-week grade was either an A or an F. Students either did their pages by the deadline and got paid (an A) or didn't (an F). Only one student received an F. He had been given the responsibility of completing two pages, and he only did one. He was absent on the due date and did not turn in the front page. Another student had to stay after school and do the page because the deadline had to be met!

The work load always seems to increase with knowledge-construction projects. Students and teachers worked many long afternoons and evenings after school and even came in on Saturdays to get the job done. But, true knowledge-construction was occurring. The instructor and students had the freedom to become facilitators in a worthwhile learning project in the classroom that was of great benefit to the community.

4.4.2. Transfer of skills

There are many examples of students transferring their problem solving skills to their own lives. The following is taken from the technology/computer applications teacher's reflection journal.

> "I will never forget when one fourteen-year-old student happened to mention that he had computerized his paper route in order to save time on his paperwork. We had just finished studying Excel spreadsheet design for about ten weeks. His complaint was that one megabyte of RAM and an 800 K disk was not enough power to run his spreadsheet the way he originally wanted it to work. He adjusted it by using a newer version on a Macintosh II with 5 megabyte of RAM. He had created custom written menus and dialog boxes for generating a monthly billing statement for each of his customers. On the last day of each month he simply tucked the bill inside the paper. This was a detailed report listing each customer's name and address, all papers delivered, cost, any not delivered for vacations, previous payments and tips, and of course the total balance due.
>
> He brought his program design into school to provide a demonstration. He clicked on the menu to run his macro. Postings were happening before my eyes in a high speed fashion, bills started to come out of the LaserWriter. I told him I was very impressed. As the screen refreshed itself for last time I noticed five names appearing in a column on the screen. I ask him what the names were for. He answered simply, "Oh, those are my five highest tippers for last month."

4.5. More student projects

4.5.1. Chinese project

In the fall of 1989, a visit to the Son of Heaven Imperial Arts of China exhibit helped launch an extensive study of ancient Chinese culture. Working in small groups, students chose various topics for in-depth investigation. Instead of preparing a traditional term paper, they prepared interactive multimedia presentations based on their research. Students used computers to control and combine many media elements that included moving and still pictures, sound, music, and text. As a culminating activity, students celebrated the Chinese New Year by having an open house where students made the multimedia presentations in Chinese costumes. The classroom was decorated in the traditional Chinese fashion with pagodas, waterfalls, etc. Cultural games, music, and food were available to the many guests who attended the Open House.

4.5.2. Interdisciplinary art

ACOT juniors and seniors who took French and Spanish foreign language classes outside the ACOT complex developed their own full-color multimedia presentation study on Art on the Macintosh. The students presented this project at the Ohio Council of Foreign Language Teachers Conference in Columbus. French students studied the art of the impressionists: Matisse, Monet, Rodin, and Van Gogh. Spanish students studied the work of early 20th century artist in the Catalan region of Spain, particularly in Barcelona. Their work includes Gaudí, Picasso, Miró, and Dalí.

Early in the school year, students read biographies and began researching their artists as cooperative group projects in their language classes. The students created a consistent layout in *SuperCard* to project a professional and unified look. The pictures that represented their artists were placed into the computer through a process known as digitizing. Digitizing requires the use of a video camera, FX card, and a color space board installed in the Macintosh II for blending video and computer graphics together. The students also used *MacroMind Director*, a software package that allowed them to create animations and titling over the video. They used a sound mixer to blend music background with recorded voice and live video sound. The music was created with the aid of the Macintosh and a MIDI keyboard. MIDI represents Music Instrument Digital Interface. The French students used Sony eight-millimeter high-band cameras for taping videos at the Columbus Public Schools' French Immersion Elementary School. There they filmed a fifth-grade class discussing French impressionists and interviewed the teacher. The Spanish group went to The Ohio State University where they interviewed a graduate student from Barcelona, Spain. Afterwards, the students organized graphics and text on *SuperCard*. They created buttons on *SuperCard*, which consist of scripts that execute different commands on the computer. The final process involved pressing a videodisc from the student-created master video tape. The students that are a part of the Art on the Macintosh project also wrote scripts controlling the videodisc accessed by text and graphics on the computer to complete this interactive multimedia project.

4.5.3 Robotic Columbus

Another project was Robotic Columbus. (See Figures 4-7.) During a field trip downtown, students obtained copies of blue prints to familiar Columbus' buildings. Students were challenged to build scale models that would be robotically controlled. The students worked in pairs. They built robots and wrote programs on the Macintosh to control the timing of lights, cranes, elevators, and a high-rise window washer. Construction was made from foam core board, paper, and plastic. Students averaged about 75 hours for each of the 18 buildings in the 20' by 30' scale model. The tallest building was 40 inches representing 624 feet. Students were meticulous in their design. By using Pixel Paint, students spent hours matching the coloring, shadings, and aggregate patterns of the stones on the outside walls of the buildings. Everything was made exactly to scale, including the shape and number of windows. 450 pages were printed on a color printer at 300 dpi in order to cover all the surfaces of the buildings, streets, lawns, sidewalks, and store fronts. Because of the high quality of print, each page required about five minutes to print.

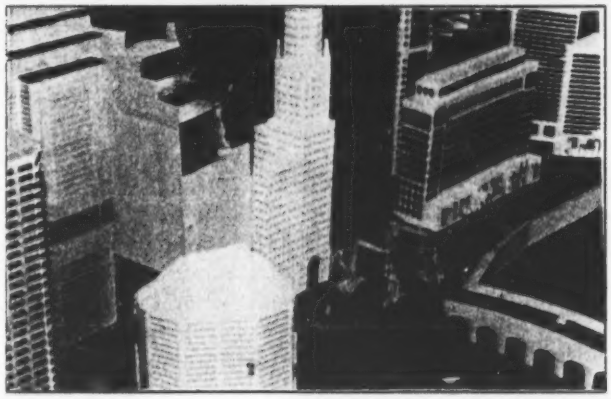


Figure 4

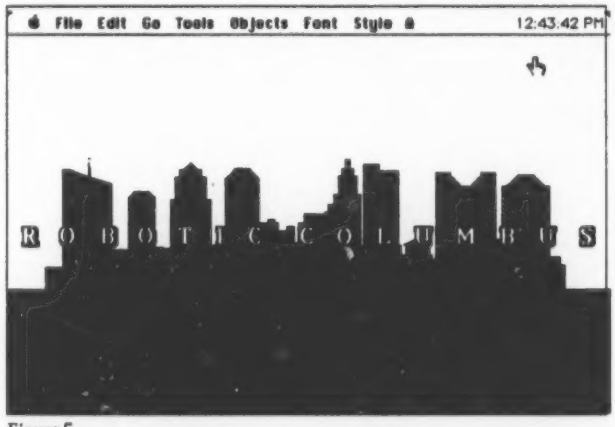


Figure 5

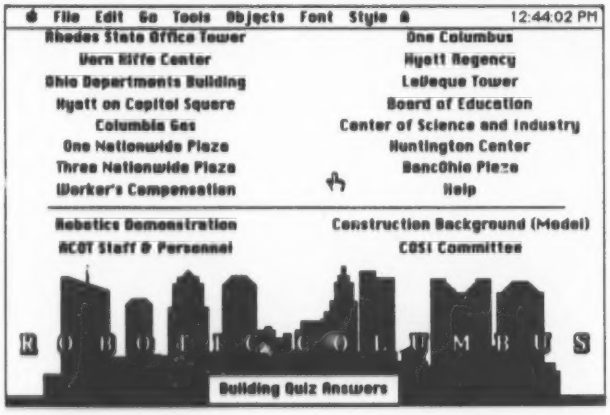


Figure 6

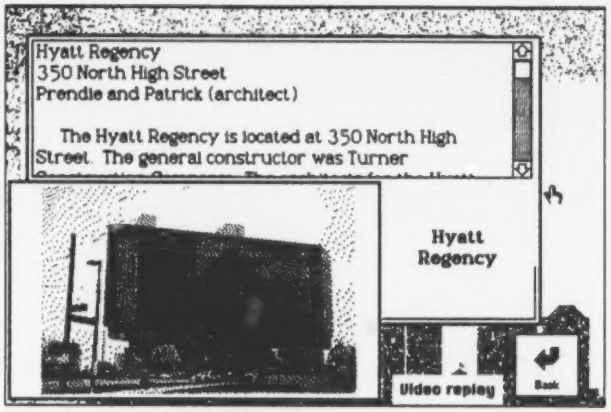

Hyatt Regency
350 North High Street
Prendle and Patrick (architect)
The Hyatt Regency is located at 350 North High Street. The general constructor was Turner
Hyatt Regency
Video replay
Back

Figure 7

This entire process was video taped and then pressed to a videodisc. Students then proceeded to do an in-depth study of the city buildings. Data collected included such things as when each building was built, its cost, and the original businesses and current businesses located in each building. Students then created their own interactive multimedia presentations using HyperCard and the videodisc.

Parents commented on the project. "I would be riding downtown, and my son would start naming the buildings followed with information. I then realized I had lived in Columbus all my life, and I only knew the names of a few buildings downtown!" Students gained an introductory perception of the robotic computer interface. Algebraic and geometric concepts and theorems were used such as ratio and proportion, measurement, and the Pythagorean Theorem. A better historical understanding of our city—with a sense of place, added yet one more dimension to the students' life-long learning experience. The final product was on display for two months at the Center of Science and Industry with scheduled student demonstrations.

4.5.4. Individual learning

Students may construct their own knowledge and understanding individually as well. Even though many knowledge-constructivists group projects have been done, academic goals are attained individually with the knowledge-constructivist approach. Through the use of *HyperCard*, students may animate the solving of an algebraic equation enhanced with sound effects created with MacRecorder. They may create their own animation of the solution to prove a geometry theorem, the animation of the frog life cycle, or a history assignment graphically illustrating geographical information. Students retain this information because they have invested so much in their assignments. They are not passively trying to absorb information from a textbook but are actively engaged in constructing and understanding the given lesson objectives.

5. What are the Effects of the Project?

5.1. Real-world success

Many examples of the transfer of knowledge and skills from the classroom to real world business solutions have occurred. Examples include: scale model building with robotics through interactive video laser disc; database management and spreadsheet designs with custom windows and dialog boxes; and a four-color 11.5" by 14.5" forty-eight page newspaper publication.

These projects, following the knowledge construction approach, were student-created solutions for Columbus community business leaders. These 10th, 11th, and 12th graders have attained such marketable skills with technology that both of our graduating classes in 1990 and 1991 were offered complete college scholarships to six universities. A total waiver of tuition, room, and board was given in exchange for students accepting the responsibility of serving as technology consultants to the universities. International businesses located in Columbus, Ohio have hired some of the ACOT students as technology consultants and are funding their college expenses. The finished product proves the success of the students' performance! After all, the essence of education is to prepare a graduate to enter the world with marketable skills, ready to contribute to life and to reach one's own potential!

5.2. Other aspects of success

Much of the program's success is not measured on today's standardized tests. Students accelerated in both quality and quantity in their writing skills compared to control groups. The ACOT students performed as well or better on their mathematics and science tests than non-ACOT students. The ACOT students have demonstrated much more knowledge and problem solving ability than standardized tests measure. For example, the tests do not show that all ACOT students have the ability and creativity to write reports using page-layout programs and illustrate the reports with their own created graphs that show supportive statistics. Not only can the ACOT students find the solution set of simultaneous equations by graphing the intersection of lines with pencil and paper, they also have the ability to solve the problem in less time by changing the parameters on a spreadsheet program that will generate and print out the graphs with much greater accuracy. The students know how to write scripts to generate their own animation for the illustration of concepts.

5.3. Demands on the teacher

Teachers must be extremely flexible and willing to quickly change lesson plans when working with technology. An example of this is shown in the following comments from the technology/computer applications teacher's reflection journal.

"I remember my first year in ACOT, in 1986 when I challenged the 9th-grade class with one of the classic problems from Algebra I: "If you fold a piece of paper 3 or 4 or even 10 times, how many layers of paper will you have?" Usually when this problem is given, a few of the students will start to discover the algebraic doubling rule of 2^n where n represents the number of folds in about 15 minutes. Was I in for surprise in the technology environment! After about 45 seconds, a student raised his hand and said 'I have the answer!' I approached his desk with much doubt but curious to see what he had done. I asked him how he did it. He responded, 'I just opened a spreadsheet, entered one in the first cell, A1. I then moved down to the second cell, A2, and entered the formula, =2*A1. I have filled down to row 2000. I have 16,000 rows and the answers are in scientific notation, how many folds do you want to know?' I was excited about the student's creative thought. I hadn't even thought of a student applying his technology problem solving skills! I was still thinking in the same manner as I had taught algebra in the past.

After some thought, I realized he had solved the problem in a more real world approach than using the traditional approach. It was faster, and the student was ready for another task. I also realized that my old 20-minute lesson was going to be a 2-minute lesson in this technology environment."

Another example from the technology/computer applications teacher's reflection journal illustrates the change in attitude experienced by many of the students.

"A student had missed 45 school days during her eighth grade school year. She also lived directly across the street from the middle school. During her first year in ACOT she only missed five days of school, which is a success story in itself, but there is more to this amazing story. She came to me in May and said that she was going to have to drop out of ACOT next year because she would be moving outside of the West High School's boundaries. I asked where she was moving. She named Reynoldsburg, about 15 miles away on the east side of Columbus. 'When are you moving?' I asked. 'Oh, we already moved in April,' she replied. I was astonished! In April, and this was May! I asked her how she was getting to school and learned that she had been getting up at 4:00 a.m. and paying to use public transportation to get to school each day. We had not noticed any difference in her attendance!"

5.5. Summary

ACOT continues to be a study of what high school students and their teachers can accomplish if they have total access to computers and other high-tech equipment at school and at home. Computers come alive through applications to real-life situations and projects that incorporate the instruction of more than one subject area. It is our hope that the ACOT approach to education encourages students to increase expectations for themselves and to become life-long learners.

5.6. Recommendations for other schools

We know that it would be difficult to replicate the ACOT classrooms without the funding support that we have received from Apple Computer, Inc. There are some modifications to the program that can adopted by school districts. Some modifications already made by Columbus Public Schools for its other 18 high schools are:

1. Recognizing the advancement made in student writing skills in the ACOT classroom, Columbus Public Schools has added Macintosh Writing Centers in all the other Columbus high schools.

2. Productivity stations made up of a Macintosh computer and an Apple LaserWriter printer were placed in all the high school journalism departments. This equipment paid for itself with its publishing ability within two years.

3. Laser Disc technology has been added to several science departments and social studies department.

A recommendation we would make to schools that are just beginning to add technology into their curriculum is to begin with Writing Centers that can be used by the entire school. Practically every subject involves some writing experience for students. After a certain level of comfort and expertise is attained, art and graphics can be added using *HyperCard* or specific graphics programs. If only one computer can be placed in a classroom, we recommend that an LCD projection panel be added to allow interactive use of the computer by the entire class. We have found that the training period for both teachers and students on the Macintosh computer is relatively short. The integration of graphics and text makes it an exciting environment for productivity by both teachers and students.

Columbus West High ACOT has had over 4000 visitors from sixteen countries. We feel fortunate to be involved with this project.

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Technology-Enriched Schools in The Netherlands

by Jef Moonen and Jos Beishuizen[1]

1. Background, Goals, and Context of the Project

1.1. National background

Since 1982 the Dutch Government has been actively stimulating the use of computers in education. As one consequence, all secondary schools in The Netherlands are equipped with computers (at least 11 per school); a core set of educational software has been made available to each school through a "starting package"; schools have been stimulated to buy additional educational software by receiving a special allocated budget for that purpose; and at least three teachers per secondary school (one of whom had to be female) have attended special training sessions.

1.2. Goals of the project

Parallel to this broad-scale introduction of computers in secondary education, the government has been especially interested in investigating the impact of computer use on education, in particular the impact that may occur when, after some time, schools will have available a much richer technology-related environment than they have at the moment. At the same time, new ideas were being developed within the Institute for Educational Research in the Netherlands about new approaches for educational research appropriate for studying the educational impact of technology-related innovations. It was agreed that more emphasis should be given to the context in which educational experiments take place. These ideas lead to the concept of a so-called "Proefstation," a name derived from the "experimental stations" that were quite common, and successful, in the Dutch agriculture research sector. In this context the government has started an additional special project, called the "Proefstation Project," which we will refer as the "Dutch Technology-Enriched Schools Project" (DTES). As specified by the government, the main task of the DTES is to investigate the impact of a technology-enriched school environment on the school as a whole: its administrative and teaching levels. Four major questions are the focus of the DTES project—What are the effects of a TES-environment on: (a) the organisation and the administration of the school (automation of aspects of administration and organisation, attitudes of teachers and administration with respect to their organisational and managerial tasks, school policy); (b) the curricula (changes in content, integration of subject areas, changes in time spent on specific subject areas); (c) the roles and opinions of teachers (with respect to the content of a subject area, didactical approaches, possibilities and limitations of computer use); and (d) the teaching-learning process (for example, new cooperative activities). The main purpose of the DTES project is to investigate these four series of questions in an interrelated way.

1.3. Preparation for the project and choice of schools

The project started in 1987 until the end of 1988 with a preparatory phase. In this phase political support, the goals of the project, and the necessary money were brought together. The government committed itself to a fixed amount of money per year, for four years. The actual project is taking place during the period 1989-1992. The budget of the project consists of two parts: (a) $200,000 (US) per year for each of the research groups, and (b) $110,000 (US) per year for each of the schools involved in the project. The government chose three universities for the project because of their prior research activities in the area. These universities were the University of Twente in Enschede in the east of the Netherlands, and the University of Utrecht and the Free University of Amsterdam in the west of the Netherlands. The subproject in Enschede was called the PRONTO (Proefstation Oost-Nederland). The subproject in the west was called PWN (Proefstation West-Nederland). Schools in the regions of the universities were invited to apply, with the major criterion being extensive prior experience with computer use, in order to move most quickly to a full-functioning, computer-rich environment. In addition, schools with experience in joint school-university activities were given priority.

As a result of this approach, three secondary schools are involved in the DTES project, two in the east and one in the west. In the PRONTO activities, the two secondary schools are Scholengemeenschap Zuid (South Community School) and Ichthus College. The Scholengemeen-schap Zuid is a large public school in Enschede with 1,400 students and 92 staff. The Ichthus College is a private secondary school with 900 students and 68 staff. The age range of the students involved is 12-18. Both schools prepare students to enter university or other types of higher education.

In PWN the available resources are concentrated in one school, Cals College in Nieuwegein, a densely populated new suburban area in the centre of the Netherlands. Cals College is a relatively young (15 years old) private secondary school with 1,400 students and 90 staff. The age range of the students involved is 12-18. The school also prepares students to enter university or other types of higher education.

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1.4. Characteristics of the Project

A primary characteristic of the project is the close cooperation of research groups and secondary schools. Researchers and teachers work together in identifying and formulating research issues. Although the research activities relate to more general questions rooted in the research activities at the universities, they are closely related to and steered by implementation issues initiated in the schools. An implied goal of the DTES project is to strengthen collaborative university/school interaction with the assumption being that this will foster better relationships between faculties of education and schools, more comprehensive and realistic research activities, and a higher likelihood of the integration of research results into school practice and decision making.

A second characteristic of the DTES project is that it is not intended to be a Model-School project, that is, it is not the intention of the project to create school situations that should be copied overall by other secondary schools in The Netherlands. The intention is rather to explore as much as possible an optimized environment for insights that might be pertinent to current schools as well as to schools as they become more technology enriched.

Given the broad perspective of the project, its research methodology cannot be limited to a specific experimental design approach. It is important to mention two aspects in this respect: (a) although the project is not meant to be a (software) development project, some software development activities did take place in order to optimize the software products available to the schools, and (b) because of the long period of time of the project (four years), the research activities must evolve in accordance with the evolution of the project. As a consequence and because of the many different activities that are incorporated with the DTES project, there is not a single research methodology that is applied to the overall project. Each component of the project uses the research methodology it finds most appropriate.

2. The Organization of the Project

The project has many aspects. We will discuss here personnel, hardware resources, and organization.

2.1. Personnel

The budget mentioned earlier has to cover all the costs of the project. A large portion of this is for personnel costs. At the university, extra researchers were appointed to execute the project, working under the supervision of regular staff members.

With respect to the schools, the extra personnel budget is primarily used to pay for released time for the teachers. Released time for teachers is the common way in the Netherlands to stimulate extra activities in schools.

In each of the schools, the extra budget for personnel was used to support two kinds of activities: (a) to create new functions to be executed by teachers already on the school staffs, and (b) to pay for released time for teachers in specific subject areas. Three new functions were created: a computer coordinator, a system manager, and a computer lab manager. Each of these function was part-time, and a teacher at the school took the responsibility. In one of the schools, the functions of system manager and lab manager were combined into a full-time position. The majority of the extra personnel budget was used to accommodate in each school the appointment of available teachers to these new functions and to give the computer coordinators additional released time.

2.2. Tasks of the coordinators

The coordinator's major tasks are twofold: (1) executive responsibility within the board of principals for all computer applications throughout the school, including the department of administration, and (2) organisation and maintenance of all educational computer applications, pre-service and in-service training, implementation of general applications software in the school, providing on-going advice and support to teachers. The major tasks of the system manager and computer lab manager are: (1) to maintain the computer laboratories, (2) to repair minor technical failures, (3) to install the software in the computer labs, (4) to copy disks for teachers, (5) to install and to maintain the Local Area Networks (LANs), and (6) often to assist teachers when technical problems occur.

2.3. Hardware resources

From a logical and ideal perspective the type of computer to be used in the schools should have been decided on the basis of the goals of the project. However, this was only partially the case. Because of political decisions about the type of computer to subsidize for use in secondary schools in the Netherlands, the type of computer acquired for the project had to be an MS-DOS-type computer. Within this context, however, the two sites decided to choose different computers: in PRONTO the emphasis was on having powerful computers; therefore the choice was directed toward AT-type computers. In PWN, however, the emphasis was on having as many computers as possible; therefore, the choice was made to buy simple PCs. Negotiations with vendors were organised at a governmental management level. There was no prescribed preference for a specific vendor.

In all three schools the computers are primarily made available in computer labs. All the computers have MS-DOS as their operating system. The Ichthus (PRONTO) computer lab was extended to 33 personal computers, including 17 ATs. Scholengemeenschap Zuid (PRONTO) has two computer labs, a total of 66 personal computers, including 17 ATs and 16 terminals connected to a minicomputer dedicated to administrative activities. At Cals College (PWN) 60 computers are located in two computer labs (16 systems in each lab) and in the office of administration. In all the schools most of the computers

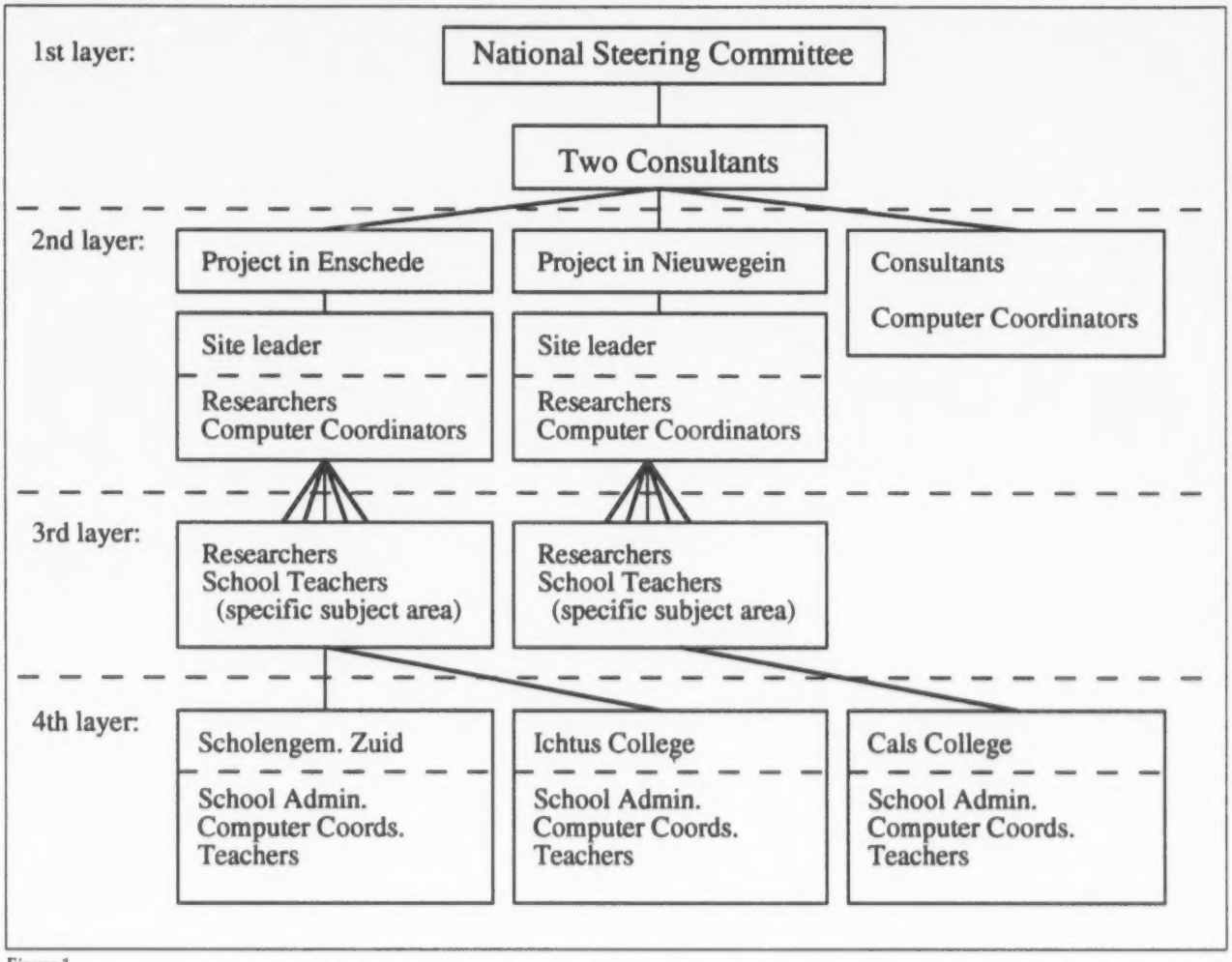

Figure 1

are networked. In every school, some of the computers are put on mobile platforms. Each school has provided the teachers' room with computers to support the preparation of the lessons. Other rooms such as the library, administrative offices, the vice-principal's office, and so on, have computers. Many printers (including laser printers), scanners, LCD screens for overhead projection, and CD-ROM players are available.

2.4. Organization

The organization of the project has many layers: a layer describing relations between the DTES project and the national committee managing all projects relating to computers in schools (this level also includes the organization of contact and cooperation between the PRONTO and PWN subprojects); a layer describing relations between the different participants within each site of the DTES project (i.e., within PRONTO and within PWN); a layer describing relations between the researchers and teachers within a specific area of investigation; and a layer describing relations within each of the participating schools. The scheme in Figure 1 gives a global overview of these layers.

At the first layer, a steering committee oversees the DTES project. The steering committee is appointed by the Ministry of Education. Two consultants have been appointed to serve as liaisons between this steering committee and the DTES project and also within the DTES project. The consultants also have the responsibility for information dissemination about the DTES project. They regularly publish booklets compiling articles and other printed material about the project. These booklets are directed toward the general Dutch secondary schools. The information for the booklets is provided by the DTES participants.

At the second layer, there are meetings between the researchers and the school coordinators. The consultants also attend those meetings. The meetings are chaired by a general site leader, one for each of the two DTES sites. (The authors of this article are the two general site leaders). The main purpose of these meetings is to coordinate the activities of the researchers and teachers and to discuss the project's progress. There are also meetings be-

tween the consultants and computer coordinators.

At the third layer, meetings are organized between researchers and teachers working in a specific subject area. These meetings happen on a bilateral basis and follow closely the specific details of each of the research activities within a subject area.

At the fourth layer, meetings are organized within each school. In PRONTO, support for the project within the school is organized at two levels: through a school-based steering committee and regular meetings of the released-time teachers. Each school has its own steering committee that overviews computer-related activities in the school. The activities within the DTES project are only a subset of the overview tasks of this committee. In Ichthus College the steering committee meets on a informal basis. In Scholengemeenschap Zuid the committee meets each week or every two weeks. At PWN a central meeting is held once every month, attended by the teachers with released-time hours and the two school coordinators. The subjects that are dealt with during these meetings are primarily of a practical nature.

2.5. Research

The research questions mentioned in Section 1.1 are very general. In PRONTO the translation of those general questions into more specific research topics was strongly influenced by previously established research activities of the four existing research groups of the Faculty of Education at the University of Twente, the university partner for DTES in the east. In cooperation with the schools, the specific research questions for DTES in the east are organized around four themes: (a) the implementation process of computer use in the curriculum; (b) the influence of computer use in the schools on the organization of those schools; (c) how relational databases can be introduced and used in schools, both in the school administration and as tools in the instruction process; and (d) how software can be built to create a flexible courseware environment that can be adapted and changed by the teacher and by the student. Each of the research themes is executed as a separate project by staff members of the Faculty of Education. From a formal point of view, each of these research projects is formally under the responsibility of the professor who is the chairman of the respective research group at the university. On the other hand, the east's general site leader is responsible for the general flow and progress of the PRONTO activities.

At PWN there was a more open approach toward the translation of the general DTES research question into more specific research themes. These themes are: (a) which changes in the management and organization structure of the school can be observed as a result of the introduction of computers in education and management; (b) which methods of in-service training and continual teacher support contribute to successful implementation of computers in education; (c) with regard to the use of accompanying materials and the changing role of the teacher, which variables are of importance to genuine integration of information technology into the existing curriculum; and (d) which research methods are appropriate to study the changes at the management, curriculum, and classroom level of the introduction of computers in education? The research team at PWN consists of researchers from the two universities and includes one mathematician, one computer scientist, two educational researchers, and two cognitive psychologists. Every researcher is involved in at least one department in the school and has accurate information about what is going on within that department. The progress in the department is regularly discussed with the research team and depending on this progress, adaptations to the research planning are made.

3. Teacher inservice and support

3.1 Inservice training

For the inservice training, a distinction should be made between courses as offered by external agencies, internal courses, and one-time demonstrations. As external courses lay a heavy burden on the school budget, the decision was made to organize most courses internally and make the school computer coordinators responsible for the execution of them.

At the beginning, such courses were specifically organised around using general system and applications software (MS-DOS, word processing, databases, and spreadsheets). Although these kinds of courses continue to be available, courses to support instructional computing, including using classroom management packages and specific subject-related packages, are also starting. As using computers in schools starts effecting administrative personnel—through the use of word processing, desktop publishing, automated handling of student grades, and registrating absenteeism—there is a growing need to train the administrative personnel as well. The system managers have followed some external courses on networking and school management systems in order to cope with those problems.

For courses about authoring environments and instructional computing, external experts were invited. Demonstrations were provided that related to the use of authoring environments, which could be used by the teachers to create or adapt courseware.

3.2. Teacher support

In addition to inservice courses, all project teachers profit from a support system consisting of other facilities, including individualized support. The following describes the variety of support available (outside of the inservice already mentioned):

1. Released-time. This varies within the schools, but for many teachers it is approximately two hours each week.

2. Counselling by coordinators and a system manager. Advice is given on technical matters (operation of hardware and software, installation of software), and educational issues. Apart from this, the value of informal, moral support should also be emphasized. The project teachers are involved in an innovation process with many uncertainties and occasional failures and disappointing experiences. The backing, which can be provided by a coordinator, is very important to stimulate the teachers to continue their efforts.

3. Sharing of experiences between teachers in a department. An effort has been made to assign two teachers in each participating department to the project. This decision was motivated by the consideration that mutual domain-oriented, pedagogical, and moral inspiration will facilitate the development of more successful computer applications than might occur through the efforts of separate teachers.

4. The research and production team. In many cases a team has been created, consisting of the teachers with released-time hours, a coordinator, a researcher, and in some instances a subject-matter specialist, to develop instructional materials.

5. Information. Special efforts have been made to supply teachers with additional information, such as periodicals, announcements, demos, new software, and so on.

6. Computers and work space. Extra sets of computers are available for teachers' use. Mobile sets are located in several wings of the school to be used for demonstration purposes in the classroom and for teacher preparation.

7. Special measures have been worked out (with certain financial and tax benefits) stimulating teachers to buy a computer for their private use at home. The idea is that they will use their personal computer also to support school activities such as reviewing courseware and preparing lessons. This initiative is called the "PC-privé project."

4. What is Happening?

4.1. General

What is happening is not that easy to summarize. Many activities are taking place at each of the schools, activities that are officially supported by the DTES project, but there are also many computer-related activities that are being initiated by the schools. However, such a distinction has no real meaning in the context of the global experiment because the research efforts are focused on identifying changes in the school environment as a result of the introduction of computers in the schools. In that respect, all the activities, whatever their origins, will influence the measured results.

Because of the historical developments of both projects, a specific description of what is happening in the PRONTO situation is somewhat different from the description of what is happening in the PWN situation. Nevertheless, there are enough similarities to give a global description that fits both situations.

4.2. Ongoing activities and support

The released-time given to teachers is insufficient to cover for the time needed to deal with the introduction of computers in their lessons. As long as everything moves smoothly, this is no problem. As soon as difficulties arise, teachers complain about the lack of time they have. Therefore, the ongoing motivation of teachers through the computer coordinators is an essential task.

In general, ongoing activities can be described at two levels: (1) the general school level, (2) the department and curriculum level.

At the general school level, efforts are being made to create a "goal-situation" at the end of the project period, December 1992. The explicitness or detail of the goal-situation is different for each of the schools. In general, however, the "blue-prints" being developed are serving as a general guideline to direct all implementation activities.

At the department and curriculum level, the research questions formulated earlier serve as a guideline to steer the activities.

4.2.1. General school level

The goal-situation at the general-school level is that by the end of the project's term the basic administrative functions in each school (administration of students, teachers, financial transactions, absentees, examination and test data) should have been automatized in one integrated system. Preparation and maintenance of the school's timetable should also have been linked to the system. The system in each school is accessible via a network for all staff members of the administration and management department. A terminal in the teachers' staff room gives access to the system. Many teachers use the computer for processing test data and use diskettes to forward their grades to the administration department. At the management level, data analysis supports decision making. Examples are: progress reports, financial statistics, analysis of trends in number of students, and analysis of absenteeism.

All kind of activities are under way to reach the described goal situation (regarding administration and record keeping), such as word processing; use of spreadsheets; use of computer software to register, summarize, and analyze students' marks, to print progress reports, to analyze absenteeism, and so forth. As a next step, such activities are being networked, extended with new activities such as the provision of centrally available information, and integrated in a school-wide system. Teachers are

making use of computers (and other facilities such as printers, scanners, and CD-ROM players) in the teachers' staff room. Support personnel are using computers as a regular tool (registration of absenteeism, registration of book loans, administration, computer use for data capture in science laboratories, etc.).

An integrated system like this, however, is complex. Actions are always linked and have far-reaching consequences and unforeseen side effects.

So, in terms of administrative task, a typical evolution of administrative automation can be observed in the schools. Schools are in this respect not different from small- to medium-sized companies.

The inservice training of teachers and support personnel in this area is concentrated on the use of general software such as word processing and spreadsheets. Such courses are taught by the computer coordinators, which puts a very heavy burden on them. However, organising inservice through other teachers or external teachers does not happen because of lack of time or high costs.

It is of major importance that large investments of time and money to foster the use of computers in the school are firmly grounded in a long-term plan developed and sustained by the school's board of executives. Decisions often have far-reaching and unforseen consequences, and should, therefore, not be based on ad-hoc considerations, but be in accordance with a broader vision on the way the school should proceed into the future.

4.2.2. Curriculum level

As a general tendency, more teachers have started using computers in their classes. This is happening in all the subject areas, although not at the same degree, depending upon the personalities and styles of the teachers involved. On the other hand, some teachers still feel concerned , and even threatened, and therefore are reluctant to start using computers in their educational practice.

With respect to the use of computers in the teaching-learning process, the main activities occur in the computer labs. The computer labs are used intensively. They are used for computer-based learning activities as well as for "informatics" teaching and also for inservice courses, workshops, and for individual use by students and teachers. Scheduling the use of the labs is becoming more difficult. Particularly in the case of computer-based learning, many organizational difficulties relating to getting access to the computers create such a burden upon the teachers that the full use of computer-based learning is still limited. Computers on carts are becoming available in order to release the pressure on the computer labs and to overcome the organizational difficulties in the case of computer-based learning. But then good (and expensive) projection devices have to be installed in the individual classes, which creates other financial problems.

There is no general implementation strategy that is applicable for all of the subject areas. Personal involvement of a teacher, or personal disinterest of a teacher in a specific division influences strongly what is happening in practice. From an overview perspective, the common approach can be described as follows:

> One teacher in each subject area takes the initiative to select courseware and to try out the selected courseware in his or her own lessons. These teachers then communicate their experiences to their colleagues in the same subject area. In this way the approach aims to involve as many teachers as possible and as many subject areas as possible.

Content-oriented computer activities occur in almost every subject area: Dutch, French, German, English, history, geography, mathematics, physics, chemistry, biology, economy, art and drawing, and informatics.

Five general categories of computer usage can be distinguished:

1. The largest category relates to the instrumental use of the computer: word processing (Dutch language, English language), spreadsheets (economics, sciences), graphical support facilities (mathematics), data bases (geography), recording of data during physical and biological experiments (sciences);

2. Hypertext facilities (history, English language);

3. Simulation programs (geography, chemistry, biology, and economics);

4. Drill-and-practice and tutorial programs (exercises with information feedback); Dutch, English and French languages (grammar training); chemistry, mathematics (solving algebra problems, fractions); geography (tutorial, test, and feedback));

5. Informatics (SQL, dBase IV).

5. What are the Effects of the Project?

5.1. General

The project runs until the end of 1992. Therefore, final results are not yet available. However, preliminary results are available and worth mentioning because of the longitudinal aspects of the study, which has been in execution now for three years. Such results should relate to the four main research questions, mentioned in Section 1.1 relating to changes in (a) the organization of the school, (b) the curriculum, (c) the role of the teacher, and (d) the teaching-learning process.

The general observation is that some changes are happening at different levels—the school, the teachers, the curriculum—but in a very slow fashion. This may not be surprising as changes in education always need a long

period of time before becoming apparent in a stable manner.

In the next sections this general observation will be illustrated by more specific observations.

5.2. Effects at the school level

Introducing computers does affect the school in many practical ways: there is a constant need for (a) more facilities (hardware, space, time); (b) extra personnel; and (c) more released-time for teachers.

Introducing and using the computer laboratory is the main physical change that has occurred in the schools. The use of computers occurs more than 80% of the time in the computer labs. But there are also computers on carts and in many other locations, such as the teachers' staff room, the offices of the administration, the library, and the principals' office.

The computer coordinator, the computer lab manager, and the system manager are new functions in the school that are absolutely necessary. The coordination of the use of computers in the school functions appropriately because the computer coordinators are doing an excellent job. The computer coordinators also maintain the communication lines with the management and administration department of the school.

Teachers are also effectively supported by the computer coordinators. They know what is going on in the departments involved, are well informed about general application software, and have clearcut ideas about the educational possibilities and limitations of computers.

The integration of the administrative activities and administrative automation is growing. The system manager plays a vital role in this process. He maintains the computers and terminals, the network, and the system software and applications installed on the network and the hard disks of the computers. However, major parts of the automation process are difficult to predict and require instant and ad hoc decision making. A school-wide network, is for this reason indispensable, and also makes maintenance as easy as possible.

In our schools, the functions of computer lab manager and system manager together require a full-time position. Coordination of computer activities, both within the administration departments and in support of the teachers, at least occupy a half-time position.

Teachers constantly claim they need more released-time. Lack of time is felt as a constant problem.

5.3. Effects on the curriculum

The first general effect to be observed is that the computer is becoming a normal and regular tool in the classroom for teachers as well as for students. Many teachers now consider the computer a useful instrument for education and use the available equipment in the same way as they use the blackboard or the overhead projector.

With respect to the existing subject areas in the schools, there is no clear indication that using computers is changing the content of the curricula. On the contrary, when teachers select educational software, their major criterion is the connection of such a package to the existing learning material, methods, and textbooks. Moreover, teachers experience a heavy work load that prevents them from engaging in time-consuming experiments with the curriculum. However, it should be emphasized that educational software often is not only closely connected to the existing curriculum, but also offers perspectives on new contents or new didactical approaches. A simulation program, demonstrating the problems of farmers in developing countries having to choose between cultivating or deforesting fields, can be used as an illustration of the topic of erosion in the geography curriculum. However, teachers using the simulation program in this way also experience students developing new problem solving and reasoning abilities regarding geographical data. The new educational opportunities offered by some computer applications sometimes serve as a catalyst encouraging teachers to reconsider their teaching strategies and teaching contents.

Handling and learning about computers does introduce new topics in the curriculum; however, these are topics specifically related to computers. Informatics and computer literacy include obvious examples of such topics, as well as learning to use the keyboard. Thus using computers to support the teaching of informatics is the most popular application of computers in the DTES project. The second most popular application is using computers in the context of learning Dutch, especially to support the writing process, and in particular, the planning of essays. It is expected that using computers will become a standard facility in several subject areas, not only Dutch. It is clear that the departments proceed along different routes and with different progress rates. Some departments are still in the stage of exploration. Teachers in these departments spend much time becoming acquainted with existing software and the use of computers in general. One or two applications are realized each year. Other departments have made up a plan to integrate computer applications into the curriculum.

Although it is not changing the curriculum of traditional subject areas, the availability of computers in the DTES schools adds many new resources to the subject areas. Many kinds of educational software are now being used: drill-and-practice, tutorials, simulations, tools, and application packages. The use of tools is most popular, followed by drill-and-practice and tutorials. There has also been a slow start in the DTES schools with respect to using computers with telecommunications and using computers for capturing and processing complicated data.

When selecting educational software teachers in the DTES project prefer the following criteria: (a) Will the new resource augment the motivation of the student? (b)

Is the new resource easy to handle by students? (c) Does the new resource have a logical, straightforward structure that is easily understood by the student?

Computers are not changing curricula but are changing some instructional strategies within existing subject areas. This is happening as far as a new approach can easily be integrated within an existing curriculum and as far as teachers and students can see some gain for themselves in terms of motivation and new skills. Some examples can be mentioned:

1. The use of computers to record and interpret data collected during experiments in the physics laboratory;

2. The integration of reading and writing instruction and practice in the department of Dutch language;

3. The use of databases in the department of geography, which has created an opportunity to enable students to reason with raw data, to arrange data into tables, and to analyze co-variance relations between variables; and

4. The use of a graphics program to depict and analyze all kinds of algebraic and trigonometric functions in the mathematics department, which has stimulated students to spend less time on drawing graphs and calculating function characteristics and more time on problem solving by comparing graphs of functions in the same plot, or by analyzing the effects of changing parameters.

Changes are often not intentionally initiated, but occur as a side-effect of integrating specific applications in the curriculum. Teachers emphasize continuity in the curriculum, and at the same time point to the changing attitude of students toward learning: more problem oriented, independent, and goal directed.

However, the integration of computer use in school practice evolves very slowly, partly because of difficulties in finding appropriate educational software, and partly because it takes a long time before teachers are accustomed to the computer.

5.3. Effects with respect to the role of the teacher

The teachers are the cornerstone of the DTES. Without their active consent and participation no changes are initiated in the classroom. They are experiencing a heavier work load, are spending more time in preparing lessons, and are reflecting more on teaching and on their subject-matter domain.

Teachers are experiencing a change in their roles. Three aspects are of importance in this respect: (a) To what extent do teachers become involved in using computers in their school-related activities? (b) What is the opinion of teachers about the value of using computers in schools? (c) Do teachers change from being instructors to being managers of information?

Teachers emphasize that during lessons in which the computer is used a change in their roles takes place. They no longer spend long periods of lecture time on expositing new subject matter, but instead explain specific problems in relation to questions of students. They often have to outline the task for which purpose the computer is being used as a tool. Students tend to become immersed in the operation of a program, thereby loosing sight of the task as a whole. Teachers also have to be aware of the fact that the immediate feedback offered by the program is properly noticed and understood by the student. New educational challenges emerge as a consequence of introducing computers in education. However, there is no clear indication that during regular classroom instruction without the help of computers, teachers in the DTES are changing from being instructors to being managers of information. On the other hand, the involvement of teachers in computer-related activities is high. Such involvement can be measured through three kinds of activities: (a) Are teachers using a computer in lesson-related activities? (b) Do teachers have and use a computer at home? (c) Do teachers participate in inservice training?

The use of computers in a school-related context in the DTES went from 40% in 1987 to 75% in 1989. While the use of computers for a general orientation to computers marginally declined from 77% in 1987 to 74% in 1989, the percentages for word processing and for using computers for grading changed from 60% to 85%, and for instructional purposes from 27% to 53%.

Two of the schools involved have stimulated teachers to buy computers for their private use at home. Attractive financial incentives have been developed for this reason (this is called the PC-privé project). The number of teachers that have participated in the PC-privé project has grown from 22% in 1987 to 70% in 1990. Teachers use their computers at home mainly for word processing (92%), to evaluate courseware (54%), and for grade-reporting activities (55%).

Inservice training can be provided in several ways: (a) directly by colleagues, (b) by self-study, (c) through an external course, and (d) through an internal course. The percentage of teachers participating in inservice training remained more or less the same throughout the project: 66%. Most of them follow training sessions at their own school (65%), and only 12% have attended a course elsewhere. The topic that gets most interest during inservice training is how computers can be used in a subject-area, followed by word processing.

The teachers generally consider three didactical functions of the computer as making a positive contribution to education: (a) The computer as a monitor of practice and training, providing exercise and immediate informative feedback; (b) The computer as a tool; and (c) The computer as a simulator. Three functions are negatively assessed: (a) The computer as a tutor; (b) The

computer as a testbank; and c) The computer as a database. The latter two functions may have been rejected because of a lack of didactical experience using these functions.

The teachers feel that working with computers creates new challenges for them and raises their motivation. Using computers also stimulates interdisciplinary approaches between subject areas. There is broad acceptance of computers in the school, and there is a positive relationship between having a computer at home and having a positive attitude toward using a computer in school.

4. Effects on the learning process

Despite all the activities in the DTES project, there is no clear evidence that working with computers is having a positive effect on the academic performance of students. Measuring changes in general achievement levels requires prolonged testing, which is outside the current scope of the DTES project. Apart from that, teachers have not changed the contents of regular achievement tests and this hinders the assessment of new skills. However, there are clear developments toward problem-oriented learning. These changes are promising. But problem-oriented approaches require new skills from the teachers, particularly strategic skills. This highlights that the role of the teacher has not lost significance in the classroom despite a technology-enriched environment.

In addition, students work very naturally with computers. Students develop a more independent attitude towards learning, show signs of increased motivation, work in a concentrated and task-oriented manner. Teachers report that students show more initiative while solving problems, more often correct mistakes after immediate feedback, and develop a more inquisitive and independent attitude toward learning.

5.5 Conclusions and recommendations

5.5.1 Change is happening, but slowly

The overall observation about the computer related activities in the Dutch DTES project in general is that some changes are happening at different levels—the school, the curriculum, the teachers, and even the students— but only in a very slow fashion.

Two observations are relevant in this respect: (a) a relatively long period of time is needed in order to be able to identify noticable changes and to make sure that those changes represent some stable picture; and (b) some change can be noticed in the first few years of change situations such as a DTES project, after which the change process stabilizes. This latter fact was measured in the DTES schools using a "Stages of Concern" questionnaire (Hall & Rutherford, 1977[2]). The results indeed show a growth in teacher involvement during the first two years of the project, followed by stabilization during the third year.

5.5.2 Implementation dip

It seems that teachers need a constant incentive in order to be stimulated to keep being involved in an innovation. After a few years they encounter the "implementation dip." The first enthusiasm has faded away, the difficulties involved in really changing education mount up, and the excitement of being in the front line of new developments dries up.

5.5.3 Progressive broadening

We suggest a "progressive broadening" strategy, on the school level, entailing a combination of a parallel depth-first and breadth-first approach, and, on the department level, a sequential orientation and planned implementation process. Start with offering extra support and facilities to teachers who are willing to be involved, but gradually replace these more or less personal facilities with structural changes in the content of the curricula and with a general availability of hardware and software. In this way, the progressive broadening strategy is an attempt to realise the ultimate goals of wide spread use of information technology in education.

The target for the project now is identifying stable results and finding ways to reach these results without a significant enlargement of the regular budget of the school. The next target will be finding appropriate approaches to disseminate the conclusions to the many other schools of The Netherlands.

Appendix

Many researchers are involved in the different research activities that constitute the DTES project, as was described in Section 2.4.

At the PRONTO site, the following persons can be contacted:

G. Carleer, S. de Vries, I. de Diana, G. Doornekamp, S. Dijkstra, P. Kommers, H. Leemkuil, H. Vlas; Address: University of Twente, Faculty of Education, PO Box 217, 7500 AE Enschede, The Netherlands.

At the PWN site, the following persons can be contacted:

H. de Haan, T. Klein, E. Visch; Address: University of Leiden, Wassenaarseweg 52, 2333 AK Leiden, The Netherlands; and M. Simons, A. Dekker; Address: University of Utrecht, Department OW&OC, Tiberdreef 4, 3561 GG Utrecht, The Netherlands.

[2] Hall, G.E., & Rutherford, W.L. (1977). *Measuring stages of concern about the innovation: A manual for the use of the SoC Questionnaire.* Austin: University of Texas.

An Information Technology School Project in Romania

by Ion Diamandi[1]

1. Backgrounds, Goals, and Context of the Project

1.1 Romanian education

An analysis of the Romanian educational system shows that present—day education is overwhelmedly dominated by the informative aspect, to the prejudice of the formative one. All the modifications of the educational programs and curricula in the last few years have had as their only effect the overloading of education with information to the extent that the overcrowding eliminated the last formative features of education. Other conclusions drawn from these analyses of Romanian education have also shown a rigid education, characterized by a nonpermissive, authoritative atmosphere, where pupils can rarely take initiative during the teacher/student interaction, and where the student/student interaction is hardly existent.

Another feature of Romanian education is the lack of correlation between the population's increasing size and the resources within the educational system. Students are crowded into schools. Some schools even have a three—phase timetable:

from 7 to 10.30 a.m.;
from 10.30 a.m. to 15.30 p.m.;
from 15.30 p.m. to 20 p.m.;

with each class including perhaps 40, sometimes even more pupils.

Yet another aspect of the Romanian educational system was that many of the textbooks were infested with ideological information. Therefore, after the Revolution in December 1989 had swept away the dictatorial system, the educational system had major challenges such as: building new schools, and writing and publishing new school books. In addition, The National Institute for Educational Sciences (ISE) has also been "born" again.

All of the factors clearly influence what will happen now with computers in Romania schools. What has been the previous experience with computers in the schools?

1.2 Previous experiences with computers in schools

Introducing technologies based on computer use into the Romanian educational system commenced after 1984, once the national PC production started. The first phase of computer introduction for students involved the following aspects:

1. Developing a curriculum that would introduce within mathematics some elementary concepts regarding basic informatics and BASIC programming.
2. Familiarizing the young generation with the new technologies by providing special computer camps and through special courses on informatics. These activities were carried out mainly by teaching BASIC. National contests also promoted programming in BASIC.
3. Research encouraged and financially supported by groups such as The Ministry of Electronics and Electrotechnics within the institutes of research (The Institute for Computers (ITC), and The Central Institute for Informatics (ICI)). This research aimed first and foremost at developing educational software but also experimented with different types of computer use with pupils.
4. Some other, more isolated achievements within the educational system.

1.3 Initial facilities and resources

Computer use was present both in schools (as the research was financially supported by the Ministry of Education and the research institutes in this field) and during pupils' spare time (activities provided within the political organization for children and youth). The abovementioned research institutes organized the planning for and elaborating of adequate equipment and software. Unfortunately, the rigid socio-economic national system in Romania as well as the technological discrepancy between our country and the more developed ones caused a slow development of these computer-related actions; therefore, only since recently can we mention that PCs and magnetic cassettes (software mostly including games) are available for sale for people in Romania.

The rather high price of the PCs as well as the small sums allocated for school endowment, coupled with the absence of a national program to introduce the new technologies in school, therefore determined a very poor school endowment with computers.

1.4 1985 initiatives

In 1985, therefore, the Ministry of Education decided to endow some secondary schools with Sinclair Spectrum-compatible computers. Then that was the only possible decision because of the technological and financial constraints in Romania. The Ministry initiative thus created an impetus for the serial production of five types of Sinclair Spectrum PC-compatible computers, namely the HC, TIM-S, COBRA, CIP, and JET (also to be found in some schools). A positive consequence was that a market was thus created for both the school's and the family's

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wishes. But, on the other hand, certain characteristics of these computers were also shortcomings in terms of integrating them into the educational system. Those shortcomings included:

1. Non-standard operating mode that determined some negative habits for children.

2. Internal memory of rather small capacity (48 K) made impossible the development of larger educational programs.

3. And last, but not least important, external memory on tape that ensures a long, unsafe program-loading period.

Consequently, computer use has been rather difficult to integrate into the educational system. An immediate consequence of the technical limitations, for example, has been an excessive amount of BASIC use (as these computers have this language incorporated within them), neglecting more or less other valuable programming languages such as Logo, which is very difficult to load from tape.

1.5 Hardware and software in the schools: Current situation

Bringing information technology into education was done "downwards," beginning with the secondary schools, so that computers in the primary and elementary schools (Grades 1—8) were considered a secondary task in the Ministry of Education plans. The "Informatics Secondary Schools" (there are five such specialized schools in the whole country) have a better endowment of computers than other secondary schools; some secondary schools with a strong tradition in mathematics also have ten or even more computers (especially in larger towns). But in general computer use is still only sporadically involved in the common, daily lesson. There are a few teachers interested in and involved in computer use, but their main aim is to teach programming and not to integrate computer use into the regular curriculum lesson. Nevertheless, we must emphasize that despite these difficulties in access to hardware and software, a great number of young people have now made remarkable achievements in learning, teaching, and practicing computer use.

The primary school situation is much the same from school to school and computers are even less represented. There are a few pilot schools that have three to six computers; some others have only a single one; and most of them have none.

Computer use during the usual lessons in the (upper) elementary school appears extremely seldom; the computer activities in schools are mostly noncompulsory, after-school courses. Only after the Revolution (December 1989) could the teacher attend special training courses about computers in the "Centre for Informatics Improvement for Teachers." There are still no special informatics books for pupils; some information technology was introduced in the mathematics schoolbooks for elementary and secondary school. But, some material (about learning BASIC and Logo programming) has been published and can replace the information-oriented traditional school books.

1.6 Current activities and the ITC

Acquiring educational software has become a great problem as each school tries to get some on its own. For the present, a library of educational programs is about to be established, each school being permitted to have access to it if the school is a subscriber. Much of the software as well as many of the projects and activities organized to familiarize the young generation with computer use have been launched and led by the ITC, The Research Institute for Computers in Bucharest. ITC is an institute of research related to computers, electronic equipment, and informatics, the only institute of this kind in the whole country. It has more than 1,000 employees as well as branches in many of the large cities in the country (Cluj, Timisoara, Constantza, Craiova, etc). The main directions of the institute are:

1. Hardware-related: Projecting requirements for producing hardware (computing systems, mini-microcomputers, PCs, CAD-CAM stations, microprocessor systems, peripheral equipment, robots, networks, etc). For the educational system ITC has specified three types of PCs: aMIC, PRAE, COBRA.

2. Software development (system and applications): Among the directions of software development are: research and projects in operating systems (for mainframes, mini and microcomputers), interpreters and compilers, databases, computer management, computer graphics, computer applications in engineering, medical, agriculture, transport, and telecommunications, and products for the educational domain.

1.7 Research activities for education within the ITC

1.7.1. Computer courses

Since 1984 a team in the institute has been researching computer use within the educational system. First, the team tested and experimented with the equipment dedicated to pupils' use and developed applications for this equipment. Thereafter, computer courses for youngsters were organized within the institute, involving about 100 pupils. The courses were divided among four age groups: 5-to-7 year olds; 8-to-11 year olds; 12-to-14 year olds; and over-14 year olds.

The aim of these courses was to involve the students in computer use, and to help them to learn different programming languages (BASIC, Logo, machine code, PASCAL, then even PROLOG); this was also a way of

testing the computers and the software as used by young people, of advertising the equipment, and of training future employees for the institute.

It is remarkable that some of smartest "pupils" at those courses were effectively involved in developing educational software within the institute (three of them are co-authors of some already commercialized software).

The courses were permanent and each group had a weekly two-hour courses, during the school year. These courses also involved researchers from other laboratories, such as the (then) computer-assisted instruction laboratory. In addition, the leaders of the institute approved and supported special camps (for computer activities and sport) twice a year, during the winter and the summer holidays (these camps are of great popularity all over the country). Swimming, tennis, skiing, skating, football, aerobics exercises, and basket-making are intermingled with computer activities (the former also taught by special instructors).

In 1987 we also experimented with a camp for computer and artistic activities.

1.7.2. Softwar e development

The team for computer assisted instruction also developed a variety of educational software: software for learning ("drill and practice") in the context of different school subjects (including learning about computer use), tutorial programs and simulations, helping programs for handicapped children, interpretors and compilers for PCs (BASIC, Logo, PASCAL), a library of utilities for developing educational software (together a kind of authoring system), a mathematical library for pupils in the secondary school, and computer games. Some of the ITC applications achieving national success are: SIM Z-80, a graphic simulator for learning the use of microprocessors; TUTOR, a set of programs used to teach BASIC; MATH, a library of programs for mathematics; Logo; tapes with computer games; and others. The ITC research was mostly financed by the Ministry of Electronics and Electrotechnics.

1.8 School-based research

Computer technologies in education have been the subject of research with respect to the following sequence of priorities:

1. Familiarizing children with computers in the educational system as an element of their own culture;

2. Integrating computer use in school by learning BASIC;

3. Integrating computer use in school using the Logo methodologies.

To develop this research, a stronger involvement of the researchers from the ITC within the educational system has been needed as the only way of effectively integrating computers in the usual daily lessons in the schools (as well as helping the research team to better understand the teachers' problems). Therefore, since the school year 1987-88, the research team has been collaborating with Dimitrie Cantemir Secondary School (an important secondary school with a strong tradition in mathematics) and School No. 56, an elementary school. Both these schools are in Bucharest.

1.9 School No. 56

School 56 has become the main interest of the ITC research team because this team preferred to work with small children: first, because experiments with such young subjects had been less encouraged previously and, second, because this is the age when mental structures basic for further cognitive development are taking shape. This paper will describe only the experiments in School No. 56.

1.9.1. Start of computer use at School No. 56

When the school was endowed with computers, a few teachers in school asked the ITC specialists for help and so began the collaboration. The reasons for School 56 to become a technology-enriched school were many:

1. The school had an initial endowment of computers;

2. Young, enthusiastic teachers in the school showed themselves to have a full and eager interest in introducing new technologies in their lessons;

3. An informatics lab for computer use activities already existed;

4. Both the administrators of the school and of the ITC approved of organizing such activities.

In 1989 the cooperation was enlarged within the ITEC Project (Information Technology in Education and Children), a longitudinal research project launched by UNESCO. The Project requested a class of nine to ten-year-old pupils, with some experience in computer use, which corresponded exactly to the existing situation in School No. 56 at that time.

1.9.2 School No. 56 as a TES Project

The experiment in School No. 56 is now in a new phase as a member of a research project launched by the Ministry of Electronics and Electrotechnics about different ways to use computers in primary and elementary schools and about the overall impact of computers in the elementary school.

1.9.3. General goal and resources for the TES Project at School No. 56

The research team's first objective within this project is to change the general atmosphere in schools, making

this atmosphere more permissive, fully stimulative for pupils' creative capacities, by means of information technologies.

The school's endowment with computers is as follows:

1. During the school year 1987-88, the school got from the Ministry of Education four HC 85 PCs (Sinclair Spectrum compatible) with four monitors (black/white) and two cassette recorders (as I/O units);

2. During the school year 1988-89, ITC endowed the school with another HC 85 PC, plus an additional HC 85 but with a floppy disc system for I/O operations and a black-and-white monitor as display. During the same period, the Ministry endowed the school with two color monitors.

3. During the school year 1989-90, the school acquired with its own resources adequate furniture (with metalic supports) for monitors and computers. The ITC team and some teachers in the school networked the computers and managed to use the HC with floppy drive as a master computer to transmit programs to the other computers in the school (through a local-area network). The Ministry of Education also supplied the school with a JUNIOR (CP/M compatible computer) in the complete configuration, plus a printer.

4. During the school year 1990-91, the Ministry of Education endowed the school with two HC 88 PC (Sinclair Spectrum and also CP/M compatible computers) in their complete configuration.

1.9.4 School No. 56 and its neighborhood

School No. 56 is rather large (over 2500 pupils; 100 teachers); it is placed in a heterogeneous zone where the new part of the town (built in the 1970-1980) intermingles with the old part with totally different architectures. In the same neighborhood within a small distance there is an important secondary school (Mathematical Physics-orientated), as well as the Faculty of Construction Engineering, an Institute for Construction Projects, and a candy factory. The cultural background of the neighborhood, mostly directed toward the technical line, has undoubtedly influenced the level of children's learning in school.

The pupils' parents are 60% graduates of different universities; as for the other parents, they are workers and office workers, most of them in Bucharest. The school has a new architecture—it was built in 1965. The school has many classrooms including workrooms (for electrotechnics, locksmith skills, embroidering, and serving) and labs (for biology, physics, chemistry, and informatics), a sport hall, and a surgery. There are about 40 pupils in each class; the educational process is organized around three shifts (from 7 a.m. to 8 p.m.). Under these circumstances, one must admit that experimenting with computer use is a rather difficult task. Most of the pupils are Romanian citizens; a few of them are Romanian gypsies.

The cultural background of the school and the educational process within it are above the national average, but not of a special type. The headmaster is an ambitious teacher, who more or less successfully manages to maintain an equilibrium among the different tendencies in school.

2. The Organization of the Project

2.1 Partners

The following institutions contribute to the TES project in School No. 56:

1. The Ministry of Education;

2. Teachers (dealing with the organization and equipment of the school informatics laboratory, general implementation of the planning, providing reports to the Board of Inspectors of the school);

3. The Research Institute for Computers, ITC, (in charge of the implementation of information technologies in the school, software development and integration, equipping and maintaining the informatics laboratory, delivery of courses of lectures meant for teachers who want to use computers, as well as a similar set of lectures meant for pupils);

4. The National Institute for Educational Sciences (psycho—pedagogical research, psychological tests, program drafts, lesson suggestions of integration of software in subject areas, drafts of lessons).

2.2 Preparing the plans for the project

An interdisciplinary work team was formed for the preparation of the draft plans for the project. This team was made up of specialists in informatics and researchers from ITC (6), pedagogues and a psychologist from the National Institute for Educational Sciences (3) and several teachers from the school who had a certain experience in computers (4). In order to support the development of the informatics activity in the school, a technician was employed to administer the equipment and the software and to provide a minimum of maintenance. In total, then the interdisciplinary team in charge of the project planning in School No. 56 included 14 persons. Teachers of various subject areas now cooperate with the team and use specific programs during class hours.

2.3 Project activities

The project involves the following aspects:

2.3.1. Program development, software integration during class hours, and development of lessons that involve computer use (for the 1st to 8th Grades).

The activities in this component are organized according to the following procedure: meetings with teachers of different subject areas are held monthly; the aim is to find instructional problems that might arise during class and could be solved by means of technologies in ways that differ from traditional methods, as well as to identify "hot spots" within the syllabus that would benefit from computer use. Then, the specialists from ISE who belong to the team bring forward suggestions for future computer integration plans, which are afterwards improved through the subsequent suggestions made by the teachers, following an iterative process. When this step is completed, the specialists from ITC construct the software program, which is tested. Then the lesson for which the computer shall be used is planned, the execution of the lesson is surveyed and analyzed, and its efficiency is evaluated. Section 4 contains the types of programs that have been developed in this way as well as descriptions of some of them.

2.3.2. The drawing up of curriculum and of courses of lectures meant to help teach different subject areas in the syllabus by means of the BASIC language (Grades 3-8) and Logo language (Grades 5-8).

This activity is generally carried on by the specialists from ITC; the main aim is to create a curriculum that parallels as closely as possible the existing one and results in instructive activities involving some simple but mathematically significant programs. Significant concepts are brought forth, such as laws, theorems, problem solving. Some of these activities will be described in Section 4.

2.3.3. Planning the computer activities outside the framework of the school program

This generally involves teaching higher level BASIC, machine code, PASCAL, and so on, to a selected group of pupils in the 7th and 8th grades. These pupils will represent their school in various competitions or activities. These above-mentioned activities are performed by the specialists from ITC.

2.3.4. Teacher training (in BASIC and Logo).

The training consists of eight to ten lessons during intensive courses held by the specialists from ITC twice a year, each lasting two weeks. All teachers are invited to participate in these classes, but attendance is not compulsory. A 10-15% attendance rate has been achieved (generally mathematics and physics teachers and homeroom teachers). The percent shows a certain evolution as compared to previous years but still not a spectacular one (i.e., the interest that teachers exhibit for informatics is constantly, though slowly, growing). In addition, in 1990 a seminar was held as well as an activity for information sharing with teachers from another general school. The subject matter of the seminar was "Means of using computers during classes." The seminar enjoyed a wide participation.

2.3.5. Miscellaneous. This category comprises:

- Organization of program libraries and libraries for specialized documentation for informatics in school. Any teacher or pupil in the school can benefit from these resources. Cassettes, floppies, magazines, and books on informatics can be borrowed.

- Organization of a newspaper (displayed on a school wall) for informatics. It represents a tie, a communication between the teachers and the pupils interested in informatics on the one hand and the other pupils in the school on the other. Various announcements can be displayed regarding events and activities in the domain, problems to be solved on computer or programs to be achieved can be exchanged by means of the wall newspaper. We mean to change the informatics wall newspaper into a school magazine in the near future.

- Organization of educational-entertaining activities (games) especially during holidays; organization and training for informatics competitions and so on. We have also planned an informatics camp during the summer holiday.

2.4 Implementing the activities

2.4.1 Problems of hardware access

In organizing the activities planned for the project we encountered and we still do encounter a serious problem: the limited access of our pupils to more up-to-date technologies. The great number of pupils in the school, the interest the majority of them exhibits for computers, the small number of computers the school has, as well as the size of the room allocated to computer activities in the school denies, at present, access to computers for all pupils interested; moreover, organization and planning of activities in this field are rather difficult. Decisions about hardware are made by the school board.

Activities on computers are generally developed in the informatics laboratory, which is provided with special items of furniture that can accommodate six to eight computers. Usually, 20 pupils attend the computer classes at a time, so each computer is shared by

two to four pupils. Certain classes in the syllabus are also held in the laboratory, when these classes involve the use of computers. In such cases, the teacher usually divides the class into two groups and teaches the same lesson to each group. If activities using computers do not suppose individual or small-group work (for simulation programs, experiments in physics, demonstrations. etc.,) the respective classes can be held either in a classroom (and then one or two computers are brought in from the informatics laboratory) or in a different laboratory (the physics or chemistry laboratories). In the teaching activities using BASIC and Logo languages (as per Category 2.3.2 above), certain classes meant for teacher training (as per Category 2.3.4), as well as the educational-entertaining activities on computers during holidays, are also carried out in the informatics laboratory. All this proves that the informatics laboratory is very much in demand, and therefore scheduling is most difficult under the circumstances.

2.4.2 Overview of computer use

An overview of the numbers of children who participate in the different types of computer activities is:

- About 300 pupils from various classes are taking part in the activities that involve using several programs during class hours, (Category 2.3.1);
- Four classes studying BASIC (about 160 pupils) and 2 classes studying Logo (about 80 pupils) (Category 2.3.2);
- Thirty pupils within the framework of the informatics year doing activities in Category 2.3.4;
- About 100 pupils who joined the team for training-entertainment activities, (Category 2.3.5).

As some of pupils participate in several of the above-mentioned activities, we estimate that about 400 (25%) of the pupils in the school are now using the computers.

2.4.3 Computers for staff use

The meetings held by the team in charge of the project take place in the "informatics cabinet." This is a smaller room, provided with one or two computers (generally the JUNIOR computer and a printer); the program library and the informatics documentation library are also to be found in this room. The following activities involving computer work occur in this room:

1. Development/alterations and program viewing by the team of specialists;
2. Some of the classes meant for teacher training;
3. Some of the training activities for the small group of pupils who would participate in informatics competitions;
4. Activities meant for the programs library and for the documentation library (program copying, organizing of program archives, documentation printing, writing of items, etc., for the wall newspaper).

2.5 Future plans

Further activities involving computers in the school depend both on the number of computers that will be provided and on the promise made by the school board to change the present biology laboratory into a second informatics laboratory during the following school year 1991-1992. When these requirements are fulfilled, the informatics team in the school aims to launch the following activities using computers, activities that would interest a larger number of pupils in the school:

1. Teaching a course on text editing (WordStar), then printing a schoolwide monthly paper (bulletin) on informatics;
2. Teaching a course on databases (dBase), then building a school database that would contain the programs and documentation library from the school;
3. Developing creative activities on computers; teaching the pupils certain special programs for drawing (ARTSTUDIO) and in music (WHAM!), which would enable them to work creatively with the computer;
4. Teaching the school staff to use computers to solve administrative problems; using the computer, the teachers can thus tackle, for example, class schedule programming using the computer. In case the school is provided with a PC, the team of specialists in charge of the project means to build a network of Spectrum-like computers with the PC as a file server.

3. Teacher Involvement, Inservice, and Support

3.1 Teachers' computer experience

The average age of the teachers in the school is rather low, and most of them were not specially trained in informatics. The younger mathematics/physics teachers attended informatics courses during their university studies, but the subject was not taught according to new trends in the domain, or according to the methodology that would enable them to adapt informatics to subject matter in the syllabus. That is why even the latter category of teachers with university training feel that they were really only introduced to informatics when they attended the lectures delivered by the ITC team in their school.

Even the elementary-level mathematics handbooks

that contain several elements of informatics focus on the FORTRAN language, which means both a lack of compatibility with the sort of equipment available in schools (on those computers there is not a FORTRAN compiler) and a lack of interest in getting pupils and teachers acquainted with informatics.

Among the teachers involved in the project there is but a small percent of computer owners (only two teachers in School No. 56 own personal computers).

3.2 Participation of teachers in the project

Participation in the project was not imposed on teachers, only the ones who were interested joined. We noticed, however, that only the young teachers agreed to join. Moreover, there is a category of teachers (around 50 years old) who oppose by different means adoption of new technologies (probably because they fear an unknown subject) while the teachers who have almost reached retirement are generally more indifferent to changes.

The negative attitudes of teachers toward new technologies should also be put down to other aspects as well:

1. A very large teaching load for the teacher and very often a stressed atmosphere, unfit for changes;

2. Supplementary training in new technologies not compulsory for teachers;

3. No laws to grant, at present, extra gains for teachers who develop supplementary activities;

4. The present organization of schools makes it difficult to plan classes using computers.

All these are objective reasons that account for the fact only young and enthusiastic teachers are taking part in the project. These teachers have the benefit of technical assistance from the research team, courses and lectures in the domain, access to the program library, as well as the possibility to take their own initiative and get involved in the work they do.

3.3 Other teacher reactions

Certain doccumentary materials (manuals) on computer use during classes, forwarded by the research team, were greeted with great interest by the teachers involved in the project. Most of those teachers stated that they didn't expect such impact on pupils as has shown up as a result the computer activities. Moreover, some teachers (mostly mathematics teachers) who are not involved in the project, have noticed certain the special qualities and skills in the group of pupils who are involved in computer use.

The research team, however, expected the teachers to be involved to a higher degree than has been the case with respect to such activities as writing scenarios of programs, forwarding of new ideas concerning the activities, and overall implementation of newer technologies.

All these lead to the conclusion that a project such as TES has little chance of success unless it is based on consulting, information, and personal help (as was the case of the ITC research team's involvement in the project), especially within the context of the present conditions in our country.

4. What's Happening?

4.1 Types of software

The activities involving computers use in School No. 56 are based on different types of software according to the character of the respective activity. Here follows a list of these types of software. The indication of the Category (see Section 2.3) is given between the brackets. The subject areas for which the software is used are also mentioned:

1. Computer assisted instruction (CAI), drill-and-practice exercises (Categories 2.3.1 and 2.3.5); disciplines: Mother Tongue, mathematics, physics, biology, English, French, informatics, etc.);

2. Tutorials (Categories 2.3.1—2.3.4; disciplines: Informatics);

3. Simulation programs (Categories 2.3.1 and 2.3.3; disciplines: biology, physics, informatics);

4. Logic-based, game-type programs (Categories 2.3.1 and 2.3.5; disciplines: mathematics, Mother Tongue, English, French, biology);

5. Utilities:

   - Drawing assistance (Categories 2.3.1 and 2.3.5);
   - Music assistance (Categories 2.3.1 and 2.3.5);
   - Mathematics library (Categories 2.3.2, 2.3.3, and 2.3.5);
   - Copying, assembling/disassembling (Category 2.3.5);
   - Text editing, database and spreadsheet programs (Category 2.3.5);
   - Compilers and interpretors—BASIC, Logo, etc. (Categories 2.3.2-2.3.4).

4.2 Description of the computer-use lessons

As already shown above, the computer use lessons aim to create a stimulating climate for developing the pupil's learning potential in a permissive atmosphere;

children ought to be curious, spontaneous, to have their own initiative. Therefore, the computer-use activities were based on the following methodologies and software:

4.2.1. Drill and practice and concept development

Adequate drill and practice software for different specific subjects (Category 2.3.1). One may say that these programs were the classic type of computer-aided instruction: the traditional patterns of learning are completed but using a new element, the computer. It became obvious that using this type of software helps the pupil to make progress in learning, and encourages him when he needs it; these programs usually reward the child with verbal feedback instead of marks.

Special attention was focused on integrating this type of computer use in lessons. Computer use in such lessons took 15-30 minutes. The software was oriented toward the most difficult problems included in the curriculum and also toward the problems for which computer use is helpful and implies more efficiency and less wasted time than traditional methods. The educational software also aimed to arm the children with correct skills and basic principles for computer use such as: learning the use of some essential keys; moving a cursor or another object on the screen; using menus; using certain programs including some simplified ones of the spreadsheet type; basic principles of dealing with a database-type collection (searching, choosing, etc.). Some of the programs in these experiments are: "The Romanian Language" (to practice hyphen use), "Words" (to practice difficult spelling), "The Noun" (recognizing the nouns in a given list of words), "The Verb" (recognizing the verbs), "Tabelad" (practicing the skill of mathematical operations and problem solving in a table-shaped form), "French" and "English" (training in foreign languages), "Graphics" (practicing the skill of graphing mathematical functions), and others.

4.2.2 Problem solving

Using some logic-based, game-type programs (competitions), both for practicing different skills and for developing logical, anticipative, creative thinking, was another direction. The teacher's indications in this respect were very important. The element of competition meant considerable increase of the pupils' concentration and interest in certain subject matter. Some of these programs are: "The Cave" (the skill of orientating oneself in a labyrinth shaped on several levels), "Animals" (skills of classifying animals on different criteria), "Geowords" (recognizing notions and concepts used in geography), "Reversi," "The Tower of Hanoi," "Logical" (skills of developing one's own strategy when solving a problem).

Generally, a computer-based lesson supposes a teacher's presentation of the problem and the software and then guidance of the students in a computer-use activity. Typically, children solve problems, individually or in groups, each child using the computer for 25 minutes. Pupils provide explanations of the the ways they solved the problem. Most of the pupils got quite involved in such computer use activities, showing special interest for this kind of activity. They were in general familiar with using software that demands individual activity and less familiarized with "working" in groups. They had no major difficulties in using the computers. The educational software had mostly the same topics as the pupils' usual curriculum, but there were also some new elements (anticipative thinking, familiarizing with the forward-backward-left-right-up-down grid for nine to ten-year-old children). According to the results of studying the use of this software, certain recommendations for developing the actual curriculum will be further developed.

4.2.3. Logo.

Teaching different subject matters in the syllabus by means of Logo methodology (Category 2.3.2). The specific Logo objectives involved learning by discovering and stimulating logical deductive thinking by underlining the relationship between essential facts and their immediate consequences. The computer is an auxiliary "tool" to help children to learn. The basic idea with regard to computer use in science is that learning must follow as closely as possible the real way of science itself. Consequently, learning starts not with principles but with logical deduction, continuing later to theorems. In this system learning doesn't suppose the former knowledge of well-shaped mathematical concepts; more than that, there is a salutary interdependence between the level of Logo programming and the level of mathematical conceptualizing. Thus the computer becomes an instrument under the pupil's effective control. Learning combines computer use with many other activities such as: measurements, experiments, observations, and "classical" drawing.

Typical Logo lessons are shaped as follows: the children are grouped (two to four children) around each computer. At the beginning of the lesson, each group gets written material containing notions, commands, and procedures related to Logo programming. Next, the written material engages the pupils in solving different exercises and experiments, trying (still by means of written questions) to get the students to draw their conclusions by reflecting upon their results.

The Logo activities mainly refer to the domain of elementary geometry. In this domain almost each theme can be the subject of a Logo experience; this choice allows the teacher to have a large range in choosing "essential points" and the level of emphasis on logical deduction according to the children's age, the level of the group, and their reaction to the previous phases. Many of the Logo activities solicit the children's creativity; some of them are game-like. Examples of the essential facts that can be discovered by pupils in these Logo activities by mean of directed experience are: the sum of the turtle's rotating to close a figure is 360 degrees; the sum of the external angles

in a regulated polygon is 360 degrees; the existence of Pi as a number; the image of an object in a plane mirror is symmetric with an object.

Both for familiarizing the children with the Logo commands and for stimulating their creative capacities, the children are asked to create different pictures—simple geometrical figures, then larger projects (a house, a sun with rays, etc.) Two aspects are strongly stressed: (a) the structural approach (downwards) in analyzing a problem (a drawing is parted into its component parts); and (b) recognizing and discovering significant elements in a problem situation. The latter aspect may be exemplified by the following situation: the pupils have to draw a cross, using the procedure for drawing a square. Pupils must discover that the two drawings have elements in common.

4.2.4. BASIC

Several basic principles were taken into account when planning and organizing classes for mathematics (Category 2.3.2) that involved use of the BASIC language. These lessons are not meant to teach programming but instead are intended to stimulate the children to solve certain mathematical problems by means of computers (in our case, by means of the BASIC language), mathematics problems that correspond to the respective school-year curriculum.

In fact, the research team worked hard to identify specific mathematics problems appropriate to the respective school years that could be solved by the pupils through means of the BASIC language without using knowledge over the students' general level in mathematics and without requiring require much information in the domain of the programming language. That is why instructions, commands, and functions specific to the BASIC language were taught at a slow pace, so as not to overburden pupils with a large number of new terms. The stress was laid on building up programs (formative aspect). Classes were structured as activity sessions for the pupils; teams of pupils that use a workstand are given various assignments.

For example, there is a series of activities developed to teach mathematics involving the first-degree function for the 7th grade.

This type of activity (problem solving) supposes that pupils were already acquainted with certain BASIC language instructions (FOR-NEXT), coordinates for the screen, and the PLOT instruction for dot tracing. The teacher will teach the lesson (according to the agreed methodology) so that connections with the subject matter (for example, the first-degree functions) are drawn. Some detailed examples follow.

Problem 1.
Draw a 256-pixel (dots) line by means of dots in the lower part of the graphics screen of the computer.

Solution: Since the length of the line is 256 pixels, the looping variable will cover a range within the limits of 0 and 255. The function y=0 will be represented graphically. In order to trace the dots, the horizontal coordinate (x) will be altered, and it will be increased from 0 to 255, while the vertical coordinate (y) is kept constant (0). When we write the program, we make x the variable that represents the horizontal coordinates and y that represents the vertical coordinates. Here is the program:

```
10 FOR X=0 TO 255
20 PLOT X,0
30 NEXT X
```

Problem 2.
Draw, using dots, a 100-pixels line, at an 80-pixels height from the lower part of the screen.

Solution: In this particular case, the looping variable will be set within the limits 1 and 100, and the straight line shall be represented by the function y=80.

Problem 3.
Draw, using dots a 100-pixels vertical line starting at a 50-pixels height.

Solution: We have a looping variable within the limits of 50 and 150 pixels; it represented by the function x=50.

```
10 FOR Y=50 TO 50+100
20 PLOT 50,Y
30  NEXT Y
```

Problems 4 and 5:
Draw, using dots, the largest rectangle or square that can be drawn on the screen. Draw, using dots, the diagonals of the square drawn in Problem 4.

Solution: To trace the diagonal, we choose at random a point on it. In order to solve the problem, we shall express the coordinate y depending on x, or to put it in another way, which is the value of the vertical coordinate when we know the horizontal one (its values range from 0.1 to 100, according to counter variable)? As we deal with a square, the points on the diagonals are placed at equal distances from the sides of the square, so the vertical coordinate (y) shall have the same size as the horizontal coordinate (x). The diagonal is placed on the line segment represented by the function y=x, and the program is:

```
100 FOR X=0 TO 175
110 PLOT X,X
120 NEXT X
```

Other problems:
The pupils are already familiar with the function-identification method, through analysis of a function's extremi-

ties (experimental method), so they can draw the other diagonal. The pupils will identify the function y=175 - x, which verifies the following equalities: x=175, y=0 and x=0, y=175.

They will write the program:

```
130 FOR X=175 TO 0 STEP -1
140 PLOT X,175-X
150 NEXT X
```

The following problem will require the drawing by means of dots the diagonals of some rectangles, and the pupils will then identify more complicated first-degree functions. For example:

Problem:
Draw, by means of dots, the diagonals of a rectangle with the sides of 50 and 70, respectively.

Solution: An angle of the rectangle is placed where the coordinates meet, (50 and 20). Then the pupils can identify the function y=20+x*50*70/100. The program is:

```
100 FOR X=50 TO 150
110 PLOT X,20+(X-50)*70/100
120 NEXT X
```

5. Effects of the Projects: Some results and reflections

We shall mention some of the results and the impact of the project on pupils, teachers, and school organization. These results are not final as the analysis of the project is still in progress.

5.1 Complexity

The first conclusion drawn is that the subject matter of a project that means to experiment with new technologies within the framework of school activities is much more complex than developing educative-instructive activities for use outside the school program (even activities that imply computer use), because the school environment supposes a larger number of variables.

5.2 Choice of activities

The project aimed at investigating various models of computer use in primary and elementary school (Grades 1-8) in Romania. From the beginning, several activities were organized (in which the research team had a good experience) that reflected a certain diversity. After an experimental period of time (of about 3 years), the plan was to choose out of these activities the best model (models) for future dissemination.

At present, the research team has altered this strategy because the analysis proved that none of the activities that suppose computer use by pupils should be rejected beforehand because pupils enthusiastically involve themselves in all types of activities, having good results from the point of view of acquired skills.

Moreover the research team considers that activities can be further diversified (as far as the school organization allows).

5.3 Other results

The team also noticed positive effects as an outcome of spontaneous contacts between groups of pupils involved in the various computer activities (discussions, exchanging of programs, etc.). Thus, the research team will further suggest focussing on some other subject-matter topics (research themes) involving computer-assisted teaching through group work—even groups of pupils of different ages—and drawing up specialized software for this purpose. In addition, the team is sensitive to the problem of stimulating a deeper involvement of girls in computer activities (90% of the pupils who take part in noncompulsory computer activities are boys).

5.4. General conclusions

In as far as teachers are concerned, experience proved that the idea of new technologies being used in schools is generally accepted but the lack of official obligation to use the technology leads to a neutral or even a negative response from some of the teachers. Though the success of our project is due to a large extent on our teachers' enthusiasm, they require nevertheless permanent training and effective guidance for long periods of time, which means effort and time-consuming activities.

As for the pupils, they embark on computer activities in a natural way. The novelty of computer technologies, as well as the different modality of study, obviously creates a deeper motivation for pupils.

It can be stated that implementing these technologies in schools has altered the atmosphere in the school.

The project as a whole stimulated study and comparative analysis among various areas of applicability of information technologies in schools, and the collaboration between school and the research field resulted in a valuable experience.

Still, the most valuable outcome of the experiment was the building up of a resource collection of computer-assisted activities upon that students reacted to with enthusiastm.

It is felt that the results are most encouraging (as reinforced by the answers to various questionnaires filled in by all the people involved in the project: pupils, teachers, researchers, the school board, private groups); nevertheless developing such a project supposes sustained organizing and research efforts, and its efficiency is hard to estimate.

Computerization of an Israeli School System: Project Comptown 1985/86-1989/90

by Elad Peled, Zimra Peled, and Gad Alexander[1]

1. Background, Goals and Context

1.1 Background

Project "Comptown" (Peled, Peled, & Alexander, 1989) was designed as a five-year (1985/86-1988/89) research-oriented educational intervention that extensively computerized schools and their "close environments" in Emory, a small town in Israel. Emory has a population of approximately 13,000 homogeneous and primarily middle class people. There is a centralized educational administration, with improvements and innovations in schools important to the community. Emory has six elementary schools, with 2,000 students and 200 teachers. All were involved in the Comptown Project.

1.2 Ecological concept

The project was guided by an ecological conceptualization (Peled, Peled, & Alexander, 1991) that (a) did not separate the school and the classroom from community support systems and from local and national policy-making institutions, and (b) perceived the ecology of the classroom as a nested arrangement of systems that affect and are affected by any intervention. We see four nested layers: the classroom, nested in the school, nested in the social-support systems of the community and its businesses, which in turn are nested in the local and national policy-making institutions.

Comptown's ecological framework is based on four assumptions:

1. Systems within an ecological arrangement are interrelated by a "cultural blueprint" that sets the pattern for the structures and processes that occur within and across the ecology.

2. Classrooms, schools, and social and political institutions are culturally dependent systems. To a large extent their properties and activities are dominated by cultural traditions, and their cultural messages have ripple effects in related systems.

3. Ordinarily cultural functioning is implicit. Its explicit effects are manifested through interventions that introduce enduring innovations into the ongoing activities of the existing systems.

4. Enduring educational innovations are generated and carried forward by two types of parallel and mutually stimulating change processes: cultural-ecological and treatment-specific. Cultural-ecological processes result from combinations of factors that act and interact within and across the ecological systems. Treatment-specific (mostly cognitive) processes result from particular treatments that are applied within the ecologically specified educational settings. IT interventions and IT policy decisions must therefore aim equally at the individual participants, the school and classroom, and their expanded ecological environment.

Comptown's premises, goals, and operational principles were built on these foundations.

1.3 Goals of the Comptown Project

The goals of the project were guided by three interrelated premises that elaborated the ecological conceptualization (Peled, Peled, & Alexander, 1991). First, in the "Information Era" the computer is a major "cultural tool" (cf. Calfee, 1985; Olson, 1985; Papert, 1987; Shavelson & Salomon, 1985). Realizing its potential in schools could restructure and augment the educational environment and narrow the gap between the "school culture" (Sarason, 1982) and the "real-world culture." Second, collaborative politicians, community leaders, and parents can create a "supportive ecology" in which an "IT culture" (directly or indirectly affecting schools) can germinate. Their demand for computer usage in schools should be satisfied. Third, if and when used "soundly" (Winkler, Shavelson, Stasz, Robyn, & Feibel, 1985), information technology provides an opportunity to generate educational innovations that can activate unrealized learning and teaching potentials.

The project's goals operationally defined this approach. These goals were to:

1. Create a computer culture in schools.

2. Create a supportive ecology in which a "future computer culture" can expand.

3. Utilize the computer's potential for innovative teaching and learning, both in and outside the school.

1.4 Comptown's general strategies

Seven operating principles implemented these three goals:

1. "High density" allocation of computers, enabling each student to have access to a computer for two to three hours a week in a computer laboratory as well as in the regular classroom.

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2. Integration of varied computer applications into as many subject matters as possible, focusing on "open tools" rather than on "closed" and "structured" courseware.

3. A system approach selecting ways and means aimed at the whole educational system (i.e., all participants and all activities), as well as its close environment.

4. A multimedia approach, where enabling participants to interact with diverse representations of the same task could develop exploratory processes and change the course of learning and instruction.

5. Use of computer tools in a mindful manner where students and teachers can be encouraged to reflect on their work and develop a new understanding of the learned task.

6. Involving the classroom's nesting systems (school, community, ministry) in making and implementing the project's policies.

7. Cultivation of positive attitudes and beliefs toward the project within and across the systems that create the ecological environment.

1.5 Away from "Book & Print"

Comptown introduced these actions to create a dramatic change in the nature of the traditional "Book & Print"-dominated classroom. It assumed that such long-term intervention would have three additional educational (cognitive) consequences. First, repeated choices mindfully made—such as weighing the "benefits" and "costs" of IT and traditional alternatives—will enhance teachers' and learners' awareness of two sets of relations: those prevailing in the "old" setting and its underlying culture, and those prevailing in the "innovative" setting and its underlying culture. Second, these cultural insights will enable learners and teachers to (a) test their "old" and "new" learning environments by comparison, and (b) mindfully change their course of learning and teaching as they progressively augment their higher-order thinking skills (Salomon, 1985, 1990; Salomon & Perkins, 1987; Salomon, Perkins & Globerson, in press). Third, understanding the links between IT and "older" strategies may cultivate two properties that are critical to educational change: (a) an intuitive understanding of the unique contributions of alternative learning environments to the ongoing cumulative learning process, and (b) the use of multiple perspectives in assessing a learned task.

1.6 Context and Organization

1.6.1 Community context and origin of the project

The Israeli school system is centralized. Governmental and municipal influence is expressed through allocation of financial resources, appointment of school principals and teachers, and determination of the curriculum and national learning standards. Within these boundaries special projects are encouraged and carried out. Comptown was a "top-down" experiment initiated by researchers (the authors of this chapter). The community of Emory became involved because its strong political leadership supported the project, its community was educationally oriented and tended to believe that computers could provide a better education for their children, and because the size of the school system (six elementary schools and one high school) was a good size relative to the goals of the project and the need to complete a basic teacher-training program within one year.

1.6.2 Project partners

The project was approved and essentially funded by the Ministry of Education and Culture. In addition, the project raised substantial contributions from private foundations. Teachers', prinicpals', and school administrators' training hours were not paid. School computer coordinators' activities were funded by the Ministry of Education and Culture. The Ministry was formally represented through its participation in a "Project Steering Committee" composed of senior officials and the project's directors. This committee followed the project's plans and thereby was the outermost ring of a multilevel contextual support arrangement. A second contextual layer was represented by a "Municipal Steering Committee" comprising of representatives of Emory's city council, its department of education, teachers, principals, and public representatives. This committee studied and endorsed the proposed project, was actively involved in hardware selection and resource allocation, mobilized local support of parents, school principals, and teachers, and guided local organizational initiatives. Finally, a core group of 68 school principals and teachers who participated in preliminary inservice courses (see Section 3) actively participated in the internal planning and decision making for the project

The project's repeated and successful attempts to systematically (a) mobilize the support of key personalities in the governmental and community systems, and (b) activate "change agents" within the immediate educational systems produced dynamic networking in which the conceptual, financial, administrative, and professional aspects of the project could be promoted and carried through.

2. The Organization of the Project: Overall Plan

The project managed, developed, and coordinated activity in five interrelated domains:

1. Intervention policy and operation planning
2. Development of curricular computer-based materials
3. Evaluation
4. Training
5. Development of community and school computer networking

2.1 Project teams

This organization was carried out by five teams. The first team, the Management Team, was in charge of conceptualization, mobilization of resources (physical and human), macropolicy and planning, development of intersystemic relations, and supervision. The team consisted of the three faculty members who initiated and headed the project.

The second team established and operated a "Center for Curriculum Development." The center adapted and developed computer-based learning materials, and provided teachers with inservice training (advising and coaching in the appropriate use of available materials). The center was staffed by (a) teachers with high academic skills and prior computer-based instruction experience, and (b) educational programmers.

The third team, the Evaluation Team, was in charge of formative and summative evaluation. This team was actively involved in each and all phases of the experiment. It developed an ecological approach to evaluation and provided the project's participants with feedback. The team was staffed by measurement experts, graduate psychology students trained in evaluation, and trained observers.

The fourth team, the Training Team, designed and conducted courses and workshops in which: (a) most of Emory's principals and teachers acquired computer and computer-based instruction skills; and (b) some of Emory's parents, retired senior citizens, and high school volunteer students acquired basic and technical computer skills. Members of the training team were computer- and computer-based instruction experts.

The fifth team, the Local Support Team, promoted community initiatives and coordinated the project's activities in and outside the schools. Regular, ongoing, administrative and guidance functions of this team were conducted by its memebers: one municipal coordinator and seven school coordinators. Figure 1 represents Comptown's overall organizational plan.

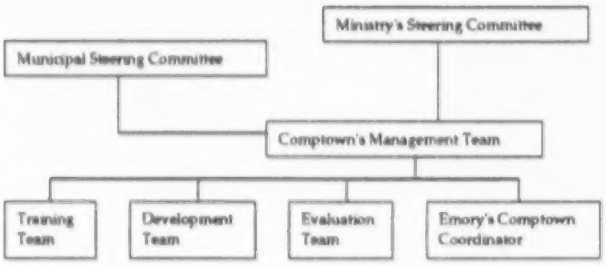

Figure 1. Comptown's overall organizational plan.

These teams were occasionally reinforced by ad-hoc teams that handled special, vital tasks. The Hardware Selection team that functioned in Emory in 1985/86 was a typical example. Its members were parents, regular classroom teachers, computer-expert teachers, and school principals. Their recommendations guided hardware acquisition and thereby influenced hardware allocation and placement, as well as the access of students and teachers to computers.

2.2 Computer access

To a large extent Comptown's hardware selection, placement, and density policies were determined by (a) school readiness to adopt the project's approach and (b) the cost and applicability of hardware. Emory's schools were therefore equipped with Commodore-64 machines. The attributes leading to the selection of Commodore were low price, dealer's support, relatively unsophisticated elementary school applications, and the largest selection of on-shelf courseware. Consequently, in Emory's elementary school system the "student per computer" ratio was 10:1.

This ratio enabled the allocation to each upper-grade classroom of four to five stand-alone computers, and the maintenance of a laboratory with 16 to 20 networked computers. The laboratory served the entire school. Five of Emory's elementary schools followed this arrangement. One school, guided by "open school" principles, distributed all the computers among the classrooms.

An early survey showed that courseware selection and application, and student access to computers were neither technical issues nor followed standard procedures. The project generated options that could be approached in different ways. Comptown did not attempt to provide a model for computer-based instruction, nor did it try to replace existing teaching routines. Rather, it nurtured involvement and guided teachers to integrate the computer into their teaching in their own ways.

3. Teacher Involvement, Inservice, and Support

3.1 Teachers' involvement

In Comptown, teachers' involvement was spelled out in terms of (a) computer skills acquisition, and (b) computer-based (CBI) proficiency and perception. Emory's teachers were technically and conceptually unprepared for CBI (at the outset of the project only 32% had some vague acquaintance with the computer and only 3% were technically capable to handle the computer). Comptown's CBI courses and ongoing activities prepared the majority of Emory's teachers to move in the new direction.

3.2 Computer skills acquisition and inservice training

Ninety-five percent of Emory's homeroom teachers and 85% of its subject-area teachers participated in and completed one of two preliminary CBI training programs offered by the project: a 270-hour program designed for school computer-coordinators, or a 70-to-120 hour program designed for regular classroom teachers. These training programs placed equal emphasis on acquisition of basic computer skills, familiarity with available computer courseware, and design of new learning materials (one-third of the training time was devoted to developing each of these skills).

Consequently teachers who participated in these programs acquired:

1. Basic computer and computer application skills (e.g. word-processing, database.)
2. Ability to operate existing authoring languages.
3. Logo familiarity.
4. Acquaintance with available courseware and its sound usages.
5. Ability to use the computer as an open tool, i.e., for help in developing learning materials in a variety of curricular subject-matters.
6. Ability to start new curricular activities that rely heavily on computer use.
7. Acquaintance with the project's conceptualization and its future plans.

The professional distribution in Comptown's CBI training programs reflected the standard teacher-professional distribution in Israeli elementary schools: 46 percent of the participating teachers were homeroom teachers (who are responsible for the educational and social activities of the class as well as for instruction); 22% were mathematics teachers; 10% were language arts teachers, and 22% taught subjects in other domains. These teachers, specialists in their content domains, were highly motivated. Their participation in a preliminary introductory course (conducted regularly once a week) was time consuming, and not paid for.

3.3 On-going support

The teachers' repeated attempts to start CBI in their classrooms could not be separated from their other classroom activities, nor could they rest on prior experience. The new classroom situation generated technical, professional, and management difficulties and called for help. Comptown responded to the emerging needs in two ways: (a) it provided professional inservice training and steady school-based guidance (this type of aid was offered and maintained by the project's "curriculum development center"); (and b) it gave technical training to parents, retired senior citizens and high school students, and used this man-power to reinforce CBI classrooms and laboratories. Both the professional and non-professional (technical) aids were fruitful in and outside school. Inside the school they helped to release some of the tensions generated by the innovation. Outside the school they created a support system that shared and responded to teachers' perceptions, endeavors, and expectations.

3.4 Teachers' awareness of the support systems

Comptown followed Emory's teachers' awareness of the supportive ecological systems throughout the last three years of the project (1987, 1988, 1989). The data presented in Table 1 demonstrate three types of support processes that teachers scored as "high" or "very high" on a 1-to-5 scale. The positive opinions of Emory's teachers about the support available to them in the project were to a large extent an intervention product in themselves that had ripple effects in related implementation frameworks.

4. What is Happening?: Description of Ongoing Processes in the Project

Because the Comptown project is over, a description of "What's Happening" in the project is also a description of the "Results" of the project (Section 5). Therefore, in this section, we will review the ongoing processes in the project; in Section 5 we will discuss cumulative results.

Implementation of the innovation began with the placement (in 1986) of computers in Emory's classrooms, and the use of computer applications with varied subject matters. These steps triggered "Physical," "Activity," and "Content"[2] accommodations, and changed work routines. The following sections describe characteristics that evolved progressively throughout the initial and ongoing implementation of Comptown in the three subsequent years: 1987, 1988, 1989.

[2] "Physical", "Activity" and "Content" indicators have often been discussed in ecological and educational literature. e.g., Bronfenbrenner (1977, 1979) and Calfee & Brown (1979) refer to physical indicators. Doyle (1986), Lamm (1976), Leontiev (1964) refer to activity indicators, and Doyle (1988), Lamm (1976), Shavelson, Winkler, Stasz, Robyn & Shala (1989) refer to content indicators.

Table 1
Teachers' Perception of Support Processes*, 1987-1989

Type of Support Process	1987	1988	1989
SCHOOL POLICIES			
School-managed CBI training	32%	21	52
School-sponsored inservice training	31	29	36
Reassuring interactions	56	62	79
SOCIAL & ATTITUDE-BASED BEHAVIORS			
Students' support	100	100	100
Teachers' support	89	73	67
Parents' support	82	85	88
School principals' support	97	100	100
School supervisors' support	88	72	79
LOCAL & GOVERNMENTAL SUPPORT			
Emory's Dept. of Education	100	100	100
Ministry of Education & Culture	92	97	83

* Percent of teachers scoring their awareness of support categories as "high" or "very high" (out of a five-point scale).

4.1 Physical accommodations: Activity centers

The most visible CBI-induced accommodations related to the physical characteristics of the classroom itself. These characteristics established contextual opportunities and constraints that enhanced (or disrupted) novel teaching and learning modes with or without the computer. Prior to the project's implementation stage, the dominant physical feature of most Emory classrooms was a "whole class" organization, i.e., a single focal activity facilitated by a single physical setting with tables in rows and chairs facing the teacher who stood in the front of the classroom. Four to five computers aligned against one of the walls divided the classroom into two parts with distinctly and different activities.

In 1987, however, a new trend could be discerned. In more than 58 percent of Emory's classrooms, the area was divided into activity centers promoting group interactions and work. The aligned computers established additional activity centers or individual teaching and learning cells that were fully integrated into the ongoing teaching and learning processes of the entire class. In contrast, classrooms (about 42%) that functioned as "whole class" organizations, used the aligned computers differently. Here computer work and focal classroom activities were entirely separated.

The "activity center" model that was functionally related to evolving activity and content accommodations continued to develop gradually. In 1989 the physical area in more than 60% of Emory's classrooms was divided into activity centers, while less than 40% maintained the prior "whole class" model.

4.2 Activity accommodations

Observations conducted in CBI and conventional "Book & Print" classrooms, and questionnaires administered to teachers in these classrooms, systematically examined three types of instructional-activity accommodations: (a) management-related interactions, (b) context-related interactions, and (c) role-determined interactions, i.e., "Student x Student" and "Teacher x Student" interactions. We will discuss changes in each of these in the following subsections.

4.2.1 Management-related interactions

Emory's teachers used both CBI and "Book & Print" instruction. However, management patterns of teachers in CBI and "Book & Print" classrooms were distinctly different. In the conventional "Book & Print" classroom "Group" learning management was emphasized most (an average of 41% of the time), followed by "Whole Class" (average of 32% of the time) while "Individual" learning management was emphasized least (an average of 27% of the time). In the CBI classrooms "Individual" learning management was emphasized most (an average of 45% of the time), followed by "Group" management (average of 35% of the time) while "Whole class" management was emphasized least (an average of 19%). Furthermore, across classrooms the variability of individual-learning management was greatest, whereas the variability of group-learning management was smallest. These results indicated that the specific conditions created in CBI classrooms enhanced individual learning, while group learning could be managed equally (and collaboratively) in both CBI and conventional "Book & Print" classrooms.

4.2.2. Context-related interactions

In Emory's classrooms differences in context-related interactions could be seen in "Book & Print" and CBI settings. In conventional "Book & Print" settings, classroom interactions were essentially tied to subject-matter and discipline-imposing needs. CBI settings created new demands. In these settings technical and computer literacy components added constraints that consistently affected interactions.

To understand this more clearly, context-related interactions were systematically observed in five typical classrooms throughout two consecutive school years (1987-to-1988) in both book-and-print and computer-using situations. In the classrooms sampled there was (a) a growth of individual, technically oriented interactions (ranging from 11%-to-19% in CBI settings, compared to 5%-to-11% in conventional settings, reflecting CBI-imposed demands); (b) a decline in subject matter-oriented interactions (ranging from 26%-to-53% in CBI settings, compared to 32%-to-62% in conventional settings), and (c) a moderate decline in discipline-related interactions (ranging from 9%-to-16% in both the CBI and conventional settings). It is important to note that although the five classrooms sampled varied in technical, subject matter, and disciplinary emphases, CBI-induced accommodations were consistent and appeared across classrooms. Furthermore, the section that follows (4.2.3) shows that CBI settings changed the proportions and the nature of "Student x Student" and "Teacher x Student" interactions.

4.2.3 Role-determined (Student x Student; Teacher x Student) interactions

In 1987 Emory's teachers reported that 61% of student-generated interactions in CBI settings were targeted toward teachers, and 39% were targeted toward another student (nearly the same as in the conventional classroom settings where the percentages were 59% "Student x Teacher" interactions and 41% "Student x Student" interactions).

In 1988 however, trends began to emerge: now 45% of student-generated interactions in CBI settings targeted teachers, and 55% targeted another student (compared to 65% "Student x Teacher" and 35% "Student x Student" interactions in conventional settings). Throughout 1989 "Student x Teacher" interactions in CBI settings declined (to 43%) and "Student x Student" interactions climbed, (reaching 57%) compared to 63% "Student x Teacher" and 37% "Student x Student" interactions in conventional classrooms.

Tables 2 and 3 show that the new interactional map had additional consequences. First, students operated the computer independently, i.e., students who did not know how to operate the computer were ordinarily helped by other students, not by the teacher. Second, activities of students operating the computer were both internally and externally oriented, emphasizing equally individual and group teaching and learning (Vygotsky, 1986).

In Emory's "Book & Print" settings, information was predominantly teacher and text provided, occasionally reinforced by student-provided information. Those restricted information recruiting and handling procedures sharply separated the learner's and teacher's roles, and systematically confined information-generating initiatives. In Emory's CBI settings, different processes developed: (a) teacher and text were but two of multiple information sources, (b) teacher and student information-recruiting and handling roles were complementary and mutually supportive, encouraging information-generating initiatives; and (c) students' autonomous information-handling processes steadily and consistently increased. In addition, both classroom management and instructional activities had a cumulative conditioning effect on emerging content accommodations.

4.3 Content accommodations

The standard curriculum of an Israeli elementary school focuses on 10 to 11 subject-matter domains (7 to 8 academic and 3 arts & crafts). Central policies influence the basic subject domains (language arts, mathematics, foreign language) in two ways: (a) through prior review of texts (i.e., teachers select their texts from a catalog of approved texts), and (b) through construction of normative achievement criteria. In other subject domains, achievement requirements are more flexible and the use of available and approved texts is the only externally imposed constraint. Within these boundaries Comptown tried to encourage four types of interrelated processes that nurtured computer-content accommodations:

1. Teachers' general belief that computers can be integrated into curricular content domains.

Table 2
Internally and Externally Oriented Interactions of Students Operating Computers: 1987-1988

Orientation	Interaction	1987	1988
External	student-student	16.8%	31.0
	student-teacher	18.7	9.7
Internal	student-computer	43.4	40.7
	student-self	21.1	18.6
Total		100%	100%

Furthermore, CBI redefined student- and teacher-shared responsibilities in ongoing information recruiting and handling activities (essential to learning and instruction). Table 3 presents three consecutive distributions (data collected in 1987, 1988, 1989) itemizing sources of information processed in CBI and "Book & Print" settings.

Table 3
Sources of Information Processed in CBI and Conventional Classroom Settings*, 1987-1989

	Classroom Setting					
	CBI	B & P	CBI	B & P	CBI	B & P
Source of Information**	1987		1988		1989	
Teacher	68	92	44	82	45	83
Students	36	44	24	27	29	41
Text Books	55	83	41	85	46	96
Computerized Data Bases	38		40		45	
Courseware	64		58		81	

CBI: Computer-based instruction; B & P:conventional "Book & Print" instruction.
* Percent of "high' and "very high" scores in a 1 - 5 scale reflecting frequency of use.
** Scoring refers to multiple sources of information.

2. Teachers' differential assessment of CBI effectiveness in specific curricular content domains.

3. Teachers' courseware preferences

4. Teachers' actual integration of computer applications into varied content domains

4.3.1 Believing that computers can be integrated into curriculum

The first process, "teachers' general belief that computers can be integrated into curricular content domains," evolved gradually. In the first year of implementation (1987), about 37 percent of Emory's teachers were convinced that the computer can be integrated into curricular instruction. In 1988, 41 percent of the teachers held this position, and in 1989, more than half (54%) of Emory's teachers believed that the computer can be integrated into regular subject matter teaching. This process created the preliminary fundamental framework for content accommodations.

4.3.2 Believing that computers can be effective within curriculum

The second process, "teachers' differential assessment of CBI effectiveness in specific curricular content domains," systematically bound teachers' professional considerations about CBI implementation to content requirements in the specific domains. Teachers were asked to give their opinion during three consecutive school years (1987, 1988, 1989) about the effectiveness of CBI in the teaching of six subject domains. Teachers' assessment of CBI effectiveness in the teaching of language arts and mathematics was consistently extremely high (in language arts the percentage of teachers who responded positively was 100, 65, and 77 over the three years; in mathematics, 70, 78, and 76). In contrast, the assessed effectiveness of CBI in the teaching of a foreign language, geography, biology and Bible was moderate to low in 1987 (11%, 22%, 4%, and 15%, respectively) but with a steadily increasing tendency (rising in 1989 to 23%, 32%, 14%, and 18%, respectively).

Teachers' differential evaluations (mathematics/language arts compared to the other set of four subjects) can be explained in two ways. First, the rigid standard achievement requirements in language arts and mathematics, with imposed drill-and-practice demands that available courseware could satisfy. The potential advantages of CBI in these domains were obvious. Achievement requirements were less stringent in other subject domains where CBI could be effectively used with either open or sophisticated computer applications. However, teachers and students were not yet adequately prepared for this.

Second, the growing awareness of the potentially rewarding integration into varied content domains of open and sophisticated computer applications, essentially reflected information and experience accumulated by the teachers in their ongoing inservice training programs rather than in their classroom teaching experiences. As this was a gradual process, straightforward adoption of either open or sophisticated computer applications was impossible.

4.3.3. Teachers' courseware preferences

The growing awareness of specific benefits of computer applications was supplemented by a third process: "teachers' courseware preferences." This process reflected teachers' growing understanding of the particular functions stimulated by each particular type of courseware. In the final implementation phase (1989), the distribution of courseware preferences was almost bimodal with "drill & practice" scoring 3.6, "games" scoring 3.3 and "word processing" scoring 3.2 (on a 1-to-5 scale). "Tutorial" scoring 2.7, and "data base" scoring 2.5 were preferred by a smaller group of teachers, while "simulations" (1.8) and

Table 5
Integration of Computer Applications into Varied Curricular Content Domains: 1987-1989
(Percent of teachers who responded positively)

Curricular Content Domains	1987	1988	1989
Language arts	73%	100	57
Mathematics	68	84	67
Foreign language (English)	6	5	5
Geography	5	17	14
Biology		0	5
Bible		5	14

Logo (1.9) were the least-preferred and least-used types of courseware.

These results suggested that teachers' actual courseware preferences were guided by two types of knowledge: (a) knowledge of externally imposed criteria (e.g., achievement criteria) and (b) knowledge of specific courseware qualities (e.g., structured or open). The extensive preference and use of drill & practice courseware in language arts and mathematics, and the very careful and slow integration of computer applications into the less-structured curricular content domains (geography, biology, Bible) confirm this assumption.

4.3.4 Teachers' actual integration of computer applications into varied content domains

The ultimate content accommodation process, i.e., "integration of computer applications into varied curricular content domains," is described in Table 5.

4.4 Teachers' overall opinions about CBI

Teachers were surveyed repeatedly during the period from 1985 to 1989 with respect to the their overall opinions about CBI and instruction. Some highlights of these surveys (responses scaled from 1-to-5) are:

1. During the preliminary training stage (1985/6), preceding the project's implementation, the teachers' expectations of possible CBI roles and effects ordinarily ranged from high to very high (4.1-to-4.8). These perceptions reflected the teachers' convictions but could not be examined in terms of real results.

2. As the project met with initial implementation difficulties, teachers' perceptions tended to decline. Ordinarily a bottom level (2.9-to-3.6) was reached during the second half of 1987 or the first half of 1988.

3. Throughout the second half of 1988 and 1989 trends began to change in two ways:

   First, the resolution of implementation difficulties facilitated the establishment of normal CBI routines and a more realistic perception of its possible contributions. Consequently, perception of CBI's role and effect generally started to rise, but they were less definitive than those expressed in the preparatory phase of the intervention (1985/6).

   Second, perceptions tested against real results were more specific and reflected changed trends that characterized the innovation such as (a) a steady decline in the perceived importance of the use of CBI for drill & practice and a steady growth in the perceived importance of the use of CBI for the development of higher-order skills; (b) an initial increase in perception of CBI as a solution of disciplinary problems (probably related to the overall effect of novelty), followed by a decline in the perceived disciplinary effect of CBI (probably reflecting routine use of CBI); (c) a dramatic unexpected decline in a perceived gender gap.

In the ecological conceptualization (Peled, Peled & Alexander, 1991) the perception of a new instructional approach operates in two ways. First, upon the introduction of the innovation, it creates a bridge between the approach and the unknown results (Schank & Abelson, 1977). Second, as the innovation evolves, it tests the initial promises of the innovation against its particular outcomes. Emory's teachers perceptions of CBI corroborated these assumptions.

4.5 Teachers' skill development

At the same time that teachers were developing in their orientation toward computer use as a tool in instruction they were also developing their own computer-related skills. Teachers' computer-use proficiency was examined periodically in two ways. First, questionnaires administered in 1987, 1988, and 1989 repeatedly surveyed the teachers' existing and acquired computer skills; second, observations routinely conducted in Emory's classrooms consistently explored technical and instructional proficiencies with computers. Questionnaires and observation data were mutually supportive and indicated gradual but steady progress. Scaled questionnaire data (measured on a 1-to-5 scale) showed:

1. Slow and steady growth in teachers' CBI self-scored proficiency (with an average 3.5 score in 1987 and 3.9 in 1989).

2. Slow and steady growth of skill in the use of "open" computer applications, clearly demonstrated in the intensified use (scored 4 or 5 on a 1-to-5 scale) of authoring language (9.7% in 1987, 26% in 1989), and database software (0.0% in 1987, 17.7% in 1989).

3. Improved technical skills (20.6% scored themselves 4 or 5 on a 1-to-5 scale in 1987, while 30.4% reached the same level in 1989).

4. Slight increase in teachers' use of home computers for school-work.

   In addition, observation data revealed:

5. A steady decline in time spent on technically related computer activity (38.5% in 1987, compared to 24% in 1989).

6. A steady increase in time spent on instructionally related computer activity (61.5% in 1987, compared to 76% in 1989).

Table 6
Indicative Physical, Activity, and Content Classroom Accommodations: 1985-1989

ACCOMMODATION	1985/86	1988/89
PHYSICAL:		
Instructional aids:	"Whole Class" oriented	"Group work" oriented
Table & chair organization:	Facing front of classroom (facilitating frontal teaching)	Optionally organized in activity centers for group work
ACTIVITY:		
Essential student learning activities:	Attentive listening & imitating & modelling	Group & machine interactions; Exploring
Classroom behavior:	Essentially controlled & quiet; Occasional misbehavior	Noisy and constantly moving; Minimal misbehavior
Dominant teacher delivery modes:	Lecturing and demonstrating	Tutoring & guiding group & student machine interactions; Using computer-based activity as a main delivery channel
CONTENT:		
Curricular goals:	Knowledge & basic skills acquisition	Development of new & enriched content areas such as: handling of information; use of multiple technologies & multiple knowledge sources

These innovative trends elicited new needs. In 1989 teachers' self-reports revealed urgent necessities. Almost 70% of the teachers asked for more preparation and training time (scored an average of 3.7 on the 1-to-5 scale). Additional needs that scored lower were nonetheless also important. These needs were: technical advice and guidance (2.5); didactic guidance (2.3); pedagogic guidance (2.1); appropriateness of courseware (2.2), and adequacy of hardware (1.6). Teachers' queries reflected maturity and a more realistic assessment of the difficulties inherent in the practice of the newly introduced approach and signaled a departure from an utopian perception of CBI.

4.6 Summary of ongoing change with regard to teachers' applications of computers in the curriculum

The reported computer applications in the different curricular content domains in the three consecutive school years (1987, 1988, 1989) revealed two trends:

> First, a decline in language arts and mathematics computer applications (in 1989), signaling a setback in drill & practice "hegemony."
>
> Second, a slow growth of computer application in varied academic content domains (four in 1987, six in 1989) revealing the preconditioning effects of teachers' practical "know-how" skills. In 1987 teachers' ability to develop their own computer applications was limited. Hence, computer-based instruction essentially relied on models that teachers and project coordinators developed in Comptown's preliminary training programs. In 1988 and 1989 teachers started to design their own computer applications. These developments, meager and cautious at the beginning, led to a new stage in which teachers adopted the innovation and applied computer uses in new and flexible ways, free of preconceived CBI scripts.

5. What are the Effects of the Project?

In 1990 the intervention in Emory's school system came to an end and the adoption of the project's systemic and process-oriented conceptualization and workings were reviewed and assessed. The rest of this chapter examines the project's cumulative effects from three perspectives explicitly defined by the project's goals:

1. The "computer culture" perspective, drawing on the development of indicative computer-oriented frameworks in classrooms and schools.
2. The "supportive ecology" perspective, evaluating the functioning of a multisystemic nesting arrangement.
3. The "innovative" perspective, drawing on exemplary attempts to use the computer's potential for innovative teaching and learning.

5.1 The "Computer Culture" Perspective

In the ecological model, a "computer culture" functions in schools if and when the computer directly and indirectly defines the interplay between individuals (teacher, student) and classroom ecological opportunities and constraints. From this perspective, classroom accommodations and school modifications are indicative, process-generated developments that cannot be separated from classroom behaviors and events. Table 6 contrasts "Physical," "Activity," and "Content" accommodations that distinguished Emory's instructional "pre-project" (1985/86) and "project-triggered" (1988/89) classroom events.

These results were repeatedly verified by classroom observations as well as by teachers and principals (about 40% of Emory's 1988/89 teaching staff) who reported that CBI-induced accommodations dramatically changed their instructional pace, pedagogical techniques, attention to individual students, and students' learning styles.

Interviews conducted with teachers, students, and school principals by the end of 1989, confirmed that the accommodated characteristics (group and individual teaching and learning rather than frontal) accurately represented a culturally-conditioned move in which the computer reshaped the orientations of principals, teachers, and learners.

Furthermore, Emory's classroom accommodations were typically reinforced by a dynamic culturally oriented school policy. The list of administrative, social and curricular school modifications that constructively interacted with CBI accommodations is represented in Table 7.

The complementary and mutually stimulating classroom and school actions legitimized and nurtured planning, spontaneity, and innovation. These accrued effects were inseparable aspects of a growing computer culture; they lasted and were cross-validated by initiatives and effectuations of teachers, school principals, computer coordinators, parents, and key community personalities, all of whom undertook Comptown's responsibilities and systematically continued to develop a supportive ecology for computer-based activity in post Comptown years.

Table 7
Administrative, Social, and Curricular School Modifications: 1985-1989

POLICY MODIFICATION	1985/86	1988/89
ADMINISTRATIVE:		
Allocation policy of instructional aids	Supply of identical aids to different classrooms	Supply of aids chosen by the teacher to meet her/his needs
SOCIAL:		
Role assignment	Complete separation between teaching & learning activities & responsibilities	Assignment of technical & teaching roles to students (e.g. older students teach the young)
CURRICULAR:		
Curricular emphases:	Basic skills acquisition & accumulation of information	Development of interdisciplinary inquiries; Information handling & use of multiple learning & teaching strategies
Special programs:	Extra classes for low achievers	Promotion of IT-based school activities: e.g., computer game library; school desktop publishing; IT training for teachers in & outside school;Parents' IT training

5.2 The "Supportive Ecology" Perspective

Comptown's "nested system" assumption implied that culturally meaningful educational processes depend on the nesting processes that cyclically act upon and interconnect schools, community, and centralized policy-making institutions. In Emory, nesting processes (stimulated by Comptown) were brought into being in three complementary ways:

1. Collaborative centralized policies.
2. Involvement of citizens and parents.
3. Belief- and attitude-based behaviors.

Table 8 reviews the centralized educational policies and voluntary activities that affected and were affected by the innovation.

The expanding nature of these actions was meaningful: In 1985/6 when awareness of the educational role of a computer culture was vague and meager, nesting arrangements were essentially prescribed and implemented by nonvoluntary organizations. In the phases that followed (1988/9), the project's systematic and persuasive intervention activity, in and outside schools, stimulated voluntary initiatives. These initiatives, along with the already established (nonvoluntary) initiatives, accelerated intersystemic dependencies and narrowed the gap between the school culture and the already expanding computer culture in the real world.

Furthermore, centralized policies and voluntary initiatives were continuously reinforced by "belief- and attitude-based behaviors." These processes operated across ecological levels and influenced the decisions and activities of all parties involved. The progressive effects of supportive "belief- and attitude-based behaviors" are presented in Table 9.

Table 8
Community Support and National Educational Policies Supporting Comptown: 1985-1989

CENTRALIZED POLICY	1985/86	1985/89
PHYSICAL SUPPORT:		
Infrastructure & equipment	Firm municipal commitment to build an IT infrastructure; Firm commitment of the Ministry of Education to support introduction of IT infrastructure & supply computers to schools	Private contribution of computers to schools; Municipal maintenance of IT infrastructure & of computers installed and used in classrooms.
PROFESSIONAL SUPPORT:		
Planning:	Municipal appointment of experts to advise purchase of computers & develop networking	Experts follow-up development of computer networking
Special programs:	Promotion of special training programs (e.g. parents & senior citizens training)	
SOCIAL SUPPORT:		
Involvement:	Voluntary parents' activities in classrooms	Parents' participation in Comptown's activities inside & outside schools

Table 9
Belief- and Attitude-Based Behaviors in Emory's Schools' Nesting Systems: 1985-1989

SYSTEM	1985	1988
MINISTRY:		
	Positive attitude toward the research project generates support in the project	Positive outcomes of the intervention and increased school & community demands result in long-term support arrangements
LOCAL POLITICAL AUTHORITIES:		
	Convinced that computer culture in schools serves local interests; attempts to promote the project's goals and resolve encountered difficultie	Demonstrate consistent attitudes; increased involvement & commitment to Comptown success.
SCHOOL PRINCIPALS:		
	Led to believe that the promised innovations can improve learning & teaching; set priorities that match the project's operational principles	As the project moved toward promised targets augment involvement & express specific interest.
TEACHERS:		
	Convinced that additional work caused by the project is worthwhile; voluntarily participate in training	Success in work leads to interest & involvement in the achievement of specific goals.
PARENTS:		
	Believe that computers carry a promise for better education; involved in activities that promote the project	Responding to enthusiastic reactions of children, parents' involvement increases

Results show that "belief- and attitude-based behaviors" were general and reassuring in the initial stages of the intervention (when efforts were directed toward the definition of general goals) and more specific during the later stages (when efforts were directed toward the attainment of specific goals). Moreover, and most important, the dialogue maintained by "belief- and attitude-based behaviors" on the part of teachers, principals, students, and key personalities in the project's nesting systems, moved the project and its nesting systems in the same direction. Frameworks were systematically developed in which, independent of Comptown's activity, new initiatives and new dialogues could be generated in the future.

5.3 The innovative perspective

Innovative undertakings were inherently built into each and all of the project's activities. Workable effects on teaching and learning were emphasized and demonstrated through exemplary studies in which (a) Comptown's intervention principles were fully implemented, and (b) the innovative potential of one particular "open" computer technology was fully exploited. Comptown's integration of IT courseware into ongoing teaching and learning was guided by two paramount intervention principles (Peled, Peled, & Alexander, 1991, 1992):

1. Patterns of instruction and integrated technology must derive from a single conceptual framework (i.e., must demonstrate congruency).

2. Realization of prescribed innovative potentials of an "open" computer technology requires modifications in prevailing patterns of instruction. These modifications, conditioned by both technology and the operating pattern of instruction, may range from trivial-organizational to major and substantial.

5.3.1 Using technology mindfully

Subsequently, Emory's teachers were trained to use computer technologies in a mindful manner (i.e., to understand the inherent educational qualities and apply the technology appropriately), while changing their pattern of instruction.

Change requirements were critical when the integrated technology involved (a) procedural and/or algorithmic understanding and manipulations (Give'on, 1988); (b) high-level interactive processing (Give'on, 1988; Salomon, 1985; Salomon & Globerson, 1987; Salomon & Perkins, 1987); and (c) exposure to unexpected teaching and learning experiences (Vygotsky, 1978; Wertsch, 1985a,b).

The acquisition of these high-level learning and teaching skills was strengthened through a four-step training procedure by which (a) teachers were trained to use the technology mindfully; (b) teachers trained students to use the technology mindfully ; (c) teachers trained students to apply the technology appropriately with curricular subject matters; (d) teachers guided students to apply the technology mindfully within an independent study.

5.3.2 Transfer of mindful training: Experiments and results

The effectiveness of the procedure was thoroughly examined (using a quasi-experimental methodology (Campbell & Stanley, 1963)) through studies of students' experiences with three particular technologies: algebraic linear function simulation, database, and word processing (Project Comptown, 1989). There were no computer-use gains in the word processing studies (results were attributed to Israeli childrens' typing difficulties), but gains of children involved in meanful use of computerized simulation and database construction were significant in specific ways:

1. In the simulation studies (conducted with eighth and ninth-graders in two consecutive years),

    a. about 50 percent of the "CBI" children handled "multiple inference" problems appropriately, while none of the "control" children could offer even partial solutions;

    b. "CBI" and "control" children performed equally in applications and "one-step" inference tasks.

2. In the database studies conducted with fourth-grade students, the acquired skills were "general" (data organization, identification of meaningful variables, formulation and testing of hypotheses), and the correlations between IQ scores and database (pencil-and-paper) test scores were lower for "control," and higher for "CBI" children. These unexpected results indicated that computerized database use may help to realize IQ potentials.

The lessons of these studies were telling in many ways:

- First, CBI guaranteed "mindful" learning and teaching;

- Second, teachers who became "learners" changed (when necessary) their patterns of instruction;

- Third, CBI effectiveness and its indicated "transfer boundaries" were "technology dependent" (cognitive effects were specific in the simulation study, and general in the database study),

- Fourth, standard achievement tests administered in Israeli schools could not capture distinctive and meaningful CBI-triggered developments.

- Finally and most important, treatment-specific effects demonstrated in specific short-term CBI studies could not be separated from systemic long-term processes that fostered the ecological contexts in which innovative teaching and learning strategies could develop rapidly.

5.4 Concluding remarks

Comptown was designed as a theory-driven intervention that examined two assumptions: (a) education is a complex cultural-ecological process in which the main effects are interactional and systemic, and (b) worthwhile intervention results cannot be achieved or understood when separated from ongoing cultural-ecological functioning. This formulation prescribed the multisystemic nature of the intervention and led to the complementarity of longitudinal explorations of multiple ecological processes and short-term treatment-specific experimentation.

From this dual perspective, the five-year study was both broad and narrow. It was broad in that it encompassed intersystemic and intrasystemic relational activities and used a single conceptual framework for the generation and analysis of cultural-ecological and treatment-specific innovations. It was narrow, in that it was confined to a single school system and to a limited number of "controlled" experiments.

Nonetheless, the ad-hoc results of the ecological and treatment-specific investigations lead to three conclusions: (a) the move from traditional to CBI-oriented school culture involves multisystemic functioning with ever-changing (linear and nonlinear) and frequently unanticipated interdependencies; (b) innovations that yield particular cognitive gains cannot be separated from dynamic and compatible nesting arrangements created by the intervention, and (c) each ecologically "controlled" experiment discloses significant systemic properties and processes that need more attention and should continuously be validated and supplemented in subsequent research-oriented interventions.

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School of the Future Project at F. M. Black Middle School

by Richard Alan Smith[1] & Anthony Sassi

1. Background, Goals, and Context of the Project

1.1 Initiation of the project

In 1985, the Houston Independent School District (HISD) and Apple Computer Inc. launched a project to create a model "school of tomorrow" to be located at Houston's F. M. Black Middle School. Initially funded for 1986 through 1987 and supported through the 1987-1988 school year, the publicized goals of the project were to demonstrate how microcomputers and related technology could make the process of instruction more efficient and effective and also to observe the effects of a computer-saturated school environment.

HISD representatives first approached Apple Computer Inc. with the project idea. After a positive review of HISD's proposal, Apple contributed 200 Apple IIe computer systems and 10 Macintosh computers to augment the 34 computers already in place at F. M. Black Middle School used to teach computer literacy. The addition brought the pupil-to-computer ratio to about 4:1. Apple also provided 80 ImageWriter II printers and 140 copies of *AppleWorks*. In addition, Apple provided technical support regarding the use of the computers.

Utilizing the resources of its Department of Technology, HISD contributed a full-time project coordinator, the services of its Instructional Development Group, the expertise of software specialists, as well as the help of graphic artists. HISD also purchased five videodisc players and 20 large-screen monitors for F.M. Black. Optical Data's "Biological Life Sciences Videodisc," and the "Core Concepts in Mathematics" videodisc series from Systems Impact were also bought by HISD and used as part of the project, as well as other Apple IIe software. F. M. Black Middle School contributed the assistance of its Teacher Technologist, a teacher who had received 296 hours of computer training provided by HISD and who functioned as the school's technology catalyst and computer literacy teacher.

1.2 Selection of F. M. Black Middle School

F.M. Black Middle School, one of 35 Grade 6-8 middle schools in Houston, which contains 1200 students, was selected to become the School of the Future after a review of its proposal and a site visit by the district's selection team consisting of senior staff from HISD's Department of Technology. At the time, the superintendent of the Houston Independent School District was a firm believer in the use of technology to support instruction. His enthusiastic emphasis on the use of computers was infectious, and of course forward-thinking principals took their cue from him. Thus, when an opportunity to obtain a school full of computers presented itself there was no lack of principals responding to the call for proposals.

The selection team was particularly impressed by F.M. Black's ethnic make up, which was nearly equally divided between white, black, and Hispanic students; the enthusiasm of its principal (who had written her doctoral dissertation on effecting change in the public schools) toward the project; and its physical plant located in a tree-filled neighborhood of working class families. However, if one element was to be identified as key to the selection of F. M. Black as the implementation site for the School of the Future it would be the school leadership factor. The combination of a highly talented principal who was an expert on facilitating change in schools coupled with the support of one of the district's most knowledgeable and reliable Teacher Technologists made a compelling and finally successful argument for the selection of F. M. Black Middle School. In fact, in a variety of other technology projects implemented in the district it was also found that the positive influence of a school leader was an important component in the initial establishment of a project.

1.3 Blending of two projects

One interesting sidelight to the implementation of the School of the Future project was its funding as part of the Apple Classroom of Tomorrow (ACOT) project, which itself was a project of the Advanced Development Group of Apple Computer. ACOT billed itself as a long-term action research and applied development project that sought to simulate a future in education when all students and teachers would have computers all of the time, hence implying significant reorganization to achieve instructional goals. In the typical ACOT project site every student and every teacher received two computers, one for use in the classroom and another for use at home. Another important component of this exciting project was that each site was limited to one class of 22 to 25 students instead of an entire school as was the case in Houston.

1.4 Goals of the project(s)

Also, bear in mind that in Houston, the idea for the project came from the central administration of the district. Those schools that responded submitted proposals that, while emphasizing the use of computers for instructional innovation, in effect used the computers to facilitate the achievement of instructional goals as de-

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fined by the Houston Independent School District and required by the Texas Education Agency. F. M. Black was no different in this approach. Hence, while the name of the project "School of the Future" implied significant reorganization, in reality the computers were used to facilitate the goals and policies of the Houston Independent School District without major reorganization.

Hence, throughout the two-year duration of the Apple funding of the project, there was constant discussion and some argument between the Apple project representatives, and the Houston Independent School District coordinating staff. In essence, both sides had similar but parallel agendas which never quite intersected. When all was said and done, we believe both groups learned that at the start of any funded project the funding agency and the receiving agency should be in agreement concerning the goals of the project and how those goals will be achieved. In Houston's case, the district felt that its goals were more than met, while we believe that Apple's Advanced Development Group felt that the Houston site never progressed as rapidly or as far as could be expected.

1.3 Evolution of the goals

The original intent of F. M. Black's proposal was to integrate computers into every branch of the curriculum. Looking back, this was an overly optimistic view of how the project would change the school. Today, instead of totally restructuring the delivery of instruction, the school seeks to work the technology into its current instructional organization causing change to become an evolution rather than a revolution.

2. The Organization of the Project

2.1 Uses of computers in the project

The computers at the School of the Future located at F. M. Black Middle School provide:

- Discovery activities that use simulations and other programs to foster student interest in education.
- Problem solving and logical thinking programs to develop student ability to use their analytical skills.
- Word processing and database programs to facilitate research and writing in all academic areas.
- Fulfillment of the state mandate for computer literacy training.
- Drill-and-practice tutorials to meet the needs of students with learning difficulties.

The computers are also used administratively, to keep records of grades, attendance, inventory, and so on. These applications enable teachers and guidance counselors to spend more time with students instead of with paperwork. While the teachers use the computers to help with their instruction, the administrative staff is also very involved with and dependent upon the use of the computers. For example, the computers are used to produce form letters to parents and teachers, for electronic mail, maintaining student demographic information, managing student discipline records, tutorial scheduling, tracking overdue library books, and textbook distribution.

2.2 Hardware resources

Three instructional laboratories contain a total of 83 computers (Apple IIes) and 30 printers. They are used for whole-class instruction. Ten computers are used by the administrative personnel of the school. These consist of four Apple IIes and six Macintosh computers. Twelve computers are located in the school's library. The other computers are placed in various classrooms. The science department has the greatest number of computers with 14. The rest are in classrooms of various disciplines in groups of three to four machines. The computers are augmented by the five videodisc players and large screen monitors used by the science, art, and mathematics teachers.

At the beginning of the project, teachers completed survey forms that indicated their level of interest in using the computers. The information helped to determine the distribution of the machines. Other factors involved in placement of the computers included the availability of software for a particular discipline, the teacher's level of experience with computers, and the physical layout of the classroom. Many classrooms and all three labs had to have wiring added before the computers could be installed. The total wiring costs were about $17,000.

Lab sites were chosen to be as convenient as possible for teachers in the two-story main building. Black Middle School also has a separate building that houses the sixth grade. No lab was placed there because at the time every classroom was in use. A former home economics room, a drafting classroom, and a math classroom in the main building were chosen because they were vacant. The home economics room and the drafting room were oversize classrooms on the first floor and were easily able to accommodate 25 to 30 computers each. The math classroom on the second floor was smaller than the other two labs but was able to hold about 22 computers. While this was convenient for teachers on the second floor, it was difficult for teachers with class sizes of 25 to 28 students who wished to have a computer for each student.

2.3 Role of the coordinator

The coordinator of the project was responsible for the daily activities involved in maintaining the project's progress and meeting the goals agreed upon by Apple and HISD. An action plan was developed by all parties involved with the coordinator seeing that the steps were completed on time. The coordinator also acted as the

liaison between Apple Computer, Inc., Black Middle School, and the Department of Technology.

Support for the project was actively pursued from many angles and came in the form of personnel and software as well as hardware commitments. Apple arranged for the coordinator to meet with representatives of various software companies to discuss donations of software for the project. This task brought thousands of dollars worth of software to the school, courtesy of companies interested in seeing the results of the project.

It was the coordinator's duty to communicate the concerns and successes of the teachers to the principal and to Apple ACOT personnel. This was done in the form of weekly reports, and more frequently in the form of interviews with teachers on a daily basis. The coordinator also acted as a software librarian, recommending and delivering software to teachers as they requested it. Computer operations were also handled in the form of minor repairs and troubleshooting hardware and software problems, and the placement of computers in classrooms where space and electrical outlets were already at a premium. The teacher technologist worked closely with the coordinator to provide a level of support that made the inclusion of technology in the curriculum as comfortable as possible for the teaching staff.

2.4 Project initiation strategies

Implementation of system-wide technological innovations in schools has traditionally been associated with problems of acceptance on the part of teachers and administrators. The introduction of computers into F. M. Black Middle School's curriculum and administration was no different in terms of the risk of rejection involved.

In order to reduce the risk of rejection and speed the use of the technology, the project was implemented by starting with a core group of teachers and administrators convinced of the utility of computers to improve student achievement. These people served as role models and project facilitators. They enabled the project to progress to encompass nearly every subject area and grade level as well as a significant portion of the tasks of the school administrators.

Several steps were used at F. M. Black Middle School in implementing the change necessary to establish the School of the Future project.

1. *A technology task force was established*
   Lead teachers from major content areas were selected to become a planning committee for technology-based education. This group included faculty members who were interested in computers as well as a few who were skeptical.

2. *Goals for the school were established*
   The school goals correlated with district-wide goals and priorities. The goals encompassed enhancing curriculum integration, increasing accountability, fostering parental involvement, increasing productivity, and providing for flexible scheduling.

3. *A set of orientation activities for teachers was established*
   In our program, which was voluntary, the participation of the teachers was the chief determinant of the success or failure of the project. By providing teachers with productive orientation activities, the project began smoothly.

4. *The software was correlated to HISD objectives.*
   Correlating software to district objectives is a time-consuming process, but it is was essential to enable the teachers to adopt technology in a short period.

5. *Software needs were identified.*
   Through surveying teachers and analyzing the curriculum, areas of software need became apparent with major subject areas dominating software requirements.

6. *School goals were developed.*
   The goals helped focus the energy of the school staff.

7. *Priorities were set.*
   The first priority was to educate the students. Hence, computer-related management techniques were evaluated to see if they contributed to attaining that goal.

8. *Instructional strategies and applications were developed.*
   Each teacher was responsible for his or her own plan for using computers. The project coordinator was available to assist.

9. *Management templates were developed.*
   In our non-networked environment, pencil-and-paper management was crucial. The staff was assisted in developing templates for record keeping that were consistent within departments and even throughout the entire school. The templates provided evidence of the computers' impact on the instructional process. The teachers who were using comprehensive software packages like SRA's "CDI Math" series, would have the students record their names, the date, the lesson numbers they attempted, and their scores. Under the teacher's supervision, these templates were (and still are) tangible evidence of student progress.

3. Teacher Involvement, Inservice, and Support

3.1 Overview of the approach to teacher training

The training approach developed for F. M. Black's School of the Future project facilitated effective, orderly integration of computers into the school's curriculum and administrative functions. In addition to exposing teach-

ers to basic computer operations and computer applications for various content areas, an important part of the training focused on new teaching methods and classroom management techniques appropriate for a computerized classroom environment. The training was provided by the project coordinator, the teacher technologist, and the district's Department of Technology.

3.2 Steps in the training plan

The following steps document how the training was accomplished at F. M. Black Middle School.

1. *Training needs were determined, and a schedule was implemented.*

   All staff members were surveyed to determine which staff members needed training and in what areas training was needed. The survey also included a question concerning the times that staff would prefer to attend sessions. This information was then entered into a database for ease of determining the most popular training times. The final schedule was created to maximize the use of available time.

   The training survey included a place for participants to write their questions and concerns about the project. It also prompted them to list the ways they could support the project. The answers to these questions were then written and distributed to each staff member by the project coordinator. Having their questions answered quickly encouraged staff members to participate and built their confidence in the project coordinator.

2. *A training classroom was set up.*

   Rooms for computer training were selected that could accommodate large training sessions (24 people). At the School of the Future, the following equipment was typically used:

   24 Apple IIe computers with two disk drives and color monitors, 80-column cards

   8-12 ImageWriter printers

   Each teacher in the session had a computer for hands-on experience with each software package. That insured better retention of the computer skills being taught. In addition, the instruction was provided using the following software:

   Apple Presents Apple (Apple IIe; Producer: Apple Computer, Inc.) A menu-driven tutorial covering the features and capabilities of the Apple IIe computer.

   Apple Presents AppleWorks (Apple IIe; Producer: Apple Computer, Inc.) This diskette guides the user through a simulation of the basic *AppleWorks'* features by posing problems and helping the user solve them. It monitors the user's progress and offers optional quizzes on what has been learned.

   DOS 3.3 System Master (Apple IIe; Producer: Apple Computer, Inc.) This program is used to demonstrate programs the user might encounter that are not menu driven and require a knowledge of DOS commands to operate.

   FredWriter (Apple IIe; Producer: California Department of Education) This is a simple-to-use, memory-resident word processor that has many features designed to turn the computer into a powerful text editor.

   Computers in Teaching (Apple IIe; Producer: Minnesota Educational Computing Consortium [MECC]) This software is an overview of instructional computing using samples from MECC courseware to demonstrate teaching strategies.

   New Horizons Educators' Computer Literacy Series (Apple IIe; Producer: Darryl L. Sink & Associates, Inc.) A multimedia package designed to help educators integrate software into their curriculum.

3. Training sessions were designed.

   Teachers were involved in selecting the training topics. This information was used to determine what proficiencies and activities were necessary for each of the training sessions. Handouts illustrating the concepts taught were available for each of the training sessions.

   Each presentation was planned with these general time breaks:

   25% time for lecture
   50% time for practice
   25% time for discussion

   Sessions were conducted at any of the following times:

   - on inservice days,
   - in one-hour sessions before school,
   - in one-, two-, or three-hour sessions after school The length of the session depended on other scheduled school activities, teacher interest level, the custodial schedule (including the availability of overtime

pay), and the cooperation of the school administrators,

- on Saturdays,
- during the teachers' planning periods where individual help was provided and teachers took advantage of instruction contained in modules that were designed to teach the basics of certain computer programs.

4. Training sessions were announced.

   The staff was given sufficient advance notice of each session. Participants were notified with a personalized memo. Announcements were placed on the bulletin boards in the office and teachers' lounge well in advance of the session. Face-to-face invitations were very effective and a good follow-up to written messages. Also, personal reminders from faculty members who were advocates of microcomputer use increased participation.

   Teachers and staff members were told the prerequisites for having computers in their rooms or using the labs. During the first year, the only prerequisite was six hours of hands-on training.

   A preregistration system was used in order to anticipate the number of people to expect. In the case of inservice days, it let the trainer know if additional sessions needed to be scheduled. Also, on inservice days, if there were several hours available, a sign-up list was posted near the employee sign-in sheet. The same session was offered in the morning and afternoon. This flexibility was appreciated by the teachers.

   Another effective means of communicating the training schedules and course descriptions was through the staff newsletter. This form of desktop publishing also highlighted outstanding classroom and administrative applications for the computer and useful implementation ideas contributed by the staff.

5. Follow-up training and assistance were provided

   In order to ensure that F. M. Black teachers had adequate knowledge of the various computer applications, individualized follow-up training was offered. This was accomplished in a variety of ways:

   - Individual assistance from the trainer or project coordinator during the teacher's planning period.
   - Individual assistance from a fellow teacher who had successfully mastered the computer application being addressed.
   - Individualized instructional modules designed for use during the teacher's planning time. These consisted of commercial tutorial programs provided with the computer, videotapes teachers could view in the library, and various hardware and software manuals kept in the library for reference. These materials are now only used occasionally because most of the teaching staff is computer literate.

6. Computer hardware and software were issued to teachers who gained proficiency in computer use.

   The first group of teachers to receive computers for classroom use were those who completed training and showed a high level of proficiency in computer applications. The amount of training successfully completed and the appropriateness of the person's teaching area were the key factors in determining which teachers began integrating computers into their classrooms. The school support staff was also trained and showed an increased level of interest and proficiency, and computers eventually became a permanent part of their work environment.

3.3 Topics for inservice

The topics mastered by School of the Future teachers who wished to use computers during the first year of the project were:

- knowledge of software and its instructional applications
- care and handling of diskettes
- proper safety precautions regarding power cords
- care and handling of hardware
- loading paper into the printer
- recognizing common disk loading problems
- identifying computer limitations
- identifying the computer's potential
- checking connections between computer and peripherals
- understanding basic computer terminology
- identifying special keys on the computer keyboard

These skills were placed on a list that each individual could maintain privately to check progress throughout the year and to build confidence.

At the School of the Future, the material taught at first was not content specific, making training sessions easier to conduct. This meant that practically everyone was learning the same skills at the same time. Thus, peer tutoring was encouraged on the part of the staff, and staff members could use each other as computer resources and benefit from each other's experiences. As the year progressed, topics got more specialized. The advanced sessions required more planning time and more materials to make them successful. The new topics also required the instructor to be well versed in a great many software packages.

Topics and schedules for these sessions included:

Topic Time Period

- Introduction to Computers
  12/85-5/86
- Keyboarding
  12/85-5/86
- Word Processing
  12/85-5/86
- Using Databases in the Classroom
  4/86
- Tools and Teacher Utilities
  4/86
- Classroom Organization
  5/86
- Introduction to Instructional Software
  (in each content area)
  9/86-5/87
- Integrating Computers into the Curriculum
  9/86-5/87
- Software Evaluation
  9/86-12/86
- Using Databases for Administration
  5/87
- Administrative Applications of
  5/87 Word Processing

3.4 Observations on inservice organization

Staff training will have its positive and negative aspects. Difficulties will arise from the lack of experience of the staff, which will dictate the need for long and intense training sessions. These sessions may prove to be too much for some staff members, and therefore, could cause animosity. An initial period of getting acquainted with the machine and hand-holding is essential. Getting teachers interested will be a small task when compared to helping them find the time for the training sessions.

At Black Middle School, participation in training sessions was optional. Initially it was suggested that substitute teachers be hired to free the teachers during the school day to attend training. However, money was not budgeted for this. Even though we were not able to use substitute teachers, we would highly recommend this strategy for similar projects in the future.

The most popular training times, as judged by attendance, were those held during the teacher's conference periods. The least attended were those scheduled for after school. At times, the project coordinator would demonstrate teaching strategies by taking over the instruction while the regular teacher could observe. This method worked especially well for helping to break the ice for some teachers who were apprehensive about using the computers with their class for the first time.

4. What is Happening?

4.1 Business partnerships

F.M. Black has acquired a business partner, Union Texas Petroleum. The connection was established in 1989 with the purpose of enabling private industry to bring new resources into the school. Union Texas Petroleum is very interested in the use of computers at F.M Black. One of the most exciting plans currently being pursued by F.M. Black and its business partner is the networking of all the instructional computers.

Efforts are presently underway to find a suitable third-party network and software. At the very least, use of the network would eliminate many of the tedious chores associated with diskette distribution to students. In addition, the possibility of being able to facilitate assignment of software according to the needs of students with a great deal of precision is also one that is of great interest to F. M. Black teachers and administrative staff.

In addition, F.M. Black received 25 Compaq Computers that were arranged as a word processing laboratory. The computers were part of 1000 computers given to the Houston Independent School District by the Compaq Computer Foundation. Although F.M. Black could have been bypassed for the receipt of these additional computers because of the already large amount of computers at the school, it was felt that the teachers were doing such a good job that the additional computers would enhance their teaching even more. To date these additional computers have been put to good use, and the students have been very enthusiastic about the additional opportunity to use word processing.

Incidentally, the use of the Compaqs is not confined to language arts teachers. In fact, teachers from

all subject areas are encouraged to use these computers to enable students to improve their writing by recognizing its importance in each of their classes.

4.2 Selection as district inservice site

F. M. Black was selected to be the site of the 1990 district-wide inservice for teacher technologists and computer literacy teachers. The school was chosen because of the outstanding classroom-based computer facilities that are now available. In fact, this was the first time that large-scale technology training was at a site other than the district's Bureau (formerly Department) of Technology, where instructional computer training had previously been concentrated.

The training at F.M. Black enabled the teachers to relate their experience directly to their own classroom. Numerous presentations were made by the teachers for the teachers on a variety of topics ranging from using computers in writing labs, to special education applications, to teaching students how to use computers to teach students mathematics for business applications, to using computers to improve higher level thinking skills.

4.3 Ongoing teacher training opportunities

During the past year (1990/1991), no formal training was held specifically for the teachers at F.M. Black. However, HISD offers ongoing computer training for infusing technology into specific content areas. Any teacher in the district may attend these free sessions in the evenings or on Saturdays. Other public education service centers in the Houston area also offer computer training for free or at a very low cost. However, the cost factor involved in providing sessions specifically for the staff at F.M. Black and the lack of a full time project coordinator have eliminated this portion of the initial program.

4.4 Cooperative project with an elementary school

One of the major results of the School of the Future was a joint pilot videodisc project with a local elementary school. This project brought elementary school children into F.M. Black and enabled them to receive science instruction via videodisc and then to write about their experience with the school's word processors. It provided an excellent way for a neighborhood elementary school without many computer resources to gauge the effectiveness of the technology with their students.

4.5 Use of computers for administrative tasks

In addition, many teachers at F.M. Black have found their administrative tasks lightened by using the computers to develop lesson plans and to keep track of a variety of records. Special education teachers used the computers to create individualized educational plans (as required by law) for their students. In fact, the computers in the school's library were virtually dedicated to the special education students. Aside from the fact that the special education teachers found the computers to be especially helpful for their students, the fact that the computers were located in the library was another opportunity for the special education students to be a part of the mainstream of the school.

4.6 Other activities

Additional developments at F. M. Black included the establishment of a computer club, which was visited by Steven Wozniak, cofounder of Apple Computer; major participation by students in our district's technology fair (with several of them winning prizes); and cross-age tutoring projects. In addition, many teachers learned to share resources with their colleagues, some to the extent that they became presenters at local and state technology conferences.

5. What are the effects of the project?

5.1 Internal evaluation

The Houston Independent School District carried out its own evaluation of the project documenting a number of changes in the school. It was found that the entire staff is aware of the technology at F. M. Black. They know of its impact on the school's curriculum. It was also found that many teachers had taken the initiative to learn about computers and used them on a voluntary basis with over 70% having regularly integrated computers into their instruction, using computers in the labs, or classroom, and for personal productivity at the very least once a week and frequently much more than that.

5.2 Broad use of computers

Thus, the F. M. Black teachers used the computers in a variety of instructional settings to improve the quality of education at F. M. Black. It is safe to say that at the time of the project's height, over 80% of the student body was involved in computerized math instruction and over 65% of the student body was involved in word processing activities and computer assisted language-arts instruction. In these examples, the computers were used both for direct instruction and as tools. At present, these use rates tend to vary by semester.

5.3 Student use and attitudes

The students learned and had a variety of skills reinforced through use of a variety of stand-alone mathematics software packages such as *CDI Math* published by SRA and used the spreadsheet from *AppleWorks* to develop their own solutions to mathematics problems. Of course, a variety of student publications flowed from use of the computer as word processor. One student summarized the situation at F. M. Black by writing in response to an evaluator's question,

> I like Black Middle School because it has a lot of computers. I think you'll like it too. It's more fun to do your work on computer than write it on paper. The computer will make you learn and have fun at the same time. It makes you want to learn. AppleWorks word processor is the software we sometimes use to write our stories and essays. It's easy to make corrections so your wouldn't have to write it over again. You get your work done much faster.[2]

Strong school leadership and comprehensive courseware were noted as key reasons that computers were in such evident use at the time of the original evaluation. The teachers reported that students have shown significant improvement after participating in computer-based tutorials in language arts and math. It is notable that the special education department at F. M. Black became very active in seeking out appropriate software and used the computers on a regular basis. One special education teacher noted that,

> If we don't use the computer then we have to use a lot of manipulatives in order to make our instruction effective. The computer has its own colorful way of reinforcing the child's learning process. It gives the opportunity to participate. To the student it's fun. Students look forward to going to the computer class. They remind us what day is theirs. It has also helped us to teach the concept of days of the week because they know which days they go to the computer class.[3]

5.4 Teachers' attitudes

In essence, teachers were extremely cooperative and receptive to the implementation of the computers at F. M. Black considering the extra time and effort they had to commit without any monetary compensation. One significant reason for this is identified by one of the school's science teachers,

> Lessons taught with computers are superior to those taught without computers. It is definitely far superior when it comes to the provision of individualized, one-to-one instruction. I cannot possibly match 10 computers because the computer gives the individuals undivided attention and instant feedback on their progress, right down to the exact percentage. It can spur them on, give them hints, and so on, while being paced by the level of the student's understanding.[4]

5.5 Summary of final phase of the evaluation

By the final phase of the evaluation it was found that the program influenced the instructional climate of the entire school, through the enhancement of staff morale, student morale, and instructional organization. As a side benefit, F. M. Black's administrative staff indicated that the use of the computers had greatly enhanced their speed and accuracy in the performance of tasks. Another unexpected benefit was that the adjusted scaled score of students taking the required statewide proficiency test improved significantly, backing up the majority of teacher claims that the use of the computers had a positive effect on their students' achievement.

5.6 Transitions between principals

Since the F. M. Black School of the Future project started, the school has changed principals five times. This series of transitions was not a result of the project. For example, in two separate instances, the principal at the time married and moved out of Texas. Also, the opportunity to pursue a university career as a professor of educational administration lured another principal away. However, even though the school has experienced several different leaders during recent years, the School of the Future project has taken firm root. Thus, each principal has found the computers to be a necessary and accepted part of the school's curriculum and teacher attitudes changed accordingly.

5.7 Application of project experiences

Hence, although Apple Computer ended its commitment to the project at the end of the second year, the present principal has made a long-term commitment to the school and is seeking additional funds to expand the use of computers. What was learned from the School of the Future Project concerning computer training for teachers, software applications, teacher apprehensions and needs, student interests and abilities along with a myriad of other details is now regularly applied to new computer implementations across the district. The School of the Future Project, an exciting prospect in 1985, has become an important part of our reality in 1991.

5.8 Recommendations for similar projects

1. Decide how you want to use computers.
   - What are your goals?
   - What are your areas of need?
   - Is there software available to meet your needs?

2. Establish an agreement with a business for funding.
   - Make certain that both project directors and the business agree on the project's goals, procedures, and timelines so that misunderstandings and frustration are minimized between both parties.

[2] Opuni, K. A. (1987). *School of the Future, F.M. Black Middle School, 1986-87 Final Report*. Houston Independent School District.
[3] From Opuni's report (see Footnote 2)
[4] From Opuni's report (see Footnote 2)

3. Establish the budget.
   - Take care to budget enough for sufficient hardware, supplies, and training to meet your goals.
   - Identify alternative ways of funding computers.

4. Know how state education regulations will affect your project.
   - Anticipate that state and district regulations may impede progress towards change; so obtain waivers from state education regulations before the project starts.

5. Decide on an administrator to take responsibility for the project
   - At least one person must know where all the loose ends belong.

6. Decide on which computers to buy.
   - Did you base hardware choice on software availability?
   - What hardware configuration will you use?
   - Is the hardware reliable and can it be inexpensively maintained?

7. Understand how your building physical limits can impede or enhance the installation of computers and other technologies.
   - Items such as electrical requirements, size of rooms, length of halls, and similar properties will all affect your efforts to establish your project.

8. Decide whether or not to dedicate some computers to alleviate teacher administrative burdens.
   - Time relieved from administrative burdens can be returned to students.

9. Orient & motivate teachers.
   - Realize that it will take time for teachers to buy into any new project.
   - Make certain the teachers understand how the project will help them. Perhaps one of the greatest obstacles we faced was when teachers became unclear as to the goal of the project. Many needed constant reassurance that what they were doing was important to their students, important to their school, and important to the school district as a whole.

10. Provide sufficient training and support.
    - Without training and support the project will fail.

11. Provide for maintenance.
    - Without limited computer downtime, teachers will cease using the equipment.
    - The purchase of a few extra computers is a necessity since there will always be one or two machines "in the shop."

12. Make certain that the teacher evaluation process views computer use as a positive factor.
    - No matter how we say the project will help teachers, if it is perceived as a detriment to their evaluation process (a major factor in job security) teachers will not adopt the project.

13. Revise the project based upon evaluation.
    - We rarely get anything right the first time.

The Quinte Lighthouse Project, Ontario

by Robert Holt[1]

1. Background and Context

In order to understand the role of the Quinte Lighthouse Project, it is necessary to describe the educational and technical setting within which the project occurred.

1.1 Government stimulation of computer use in Ontario schools

In the early 1980s, the Ministry of Education of the Province of Ontario developed a set of specifications for educational computers and issued a challenge to industry to develop such computers and to present their products to an evaluation team. Products meeting Ministry criteria would be known as GEMs—Grant Eligible Microcomputers (GEMS).

A key feature of the specifications was that the computers operate in a network environment with a user interface that was both easy to use by students of all grade levels and could be easily managed by teachers who may not have had a very extensive background in computers. An extensive suite of software would be developed privately with funding from the Ontario Ministry of Education.

Because of the initial monopoly that the UNISYS computer held in the Ontario educational market, most of the software that the Ministry commissioned was written for the UNISYS machine, the ICON (and will not run under DOS). This provided a built-in incentive for schools to continue purchasing ICONs since the software came free.

However, in the past few years the "rules" have been changed, and there are now more DOS-based computers in Ontario schools than ever before. With the introduction of software grants from the Ontario Ministry of Education, the software price and availability obstacle has been overcome. The result is that high schools now graduate students trained in industry-standard application software (WordPerfect, Microsoft Word, Lotus 123, Dbase, Autocad, etc.) Note that this is industry-standard commercial software, not software written specifically to enhance the Ontario curriculum as was the case with the OESS software developed for the ICON.

1.2 Role of the "Lighthouse Schools"

The Quinte Lighthouse Project took place in the middle of these great changes in Ontario Schools. In the spring of 1987, the Ontario Ministry of Education formulated a plan to establish one pilot school in each of the six ministry regions of the Province of Ontario. These pilot schools were to demonstrate the successful implementation of GEM computers and Ontario Educational Software in Ontario schools.

A need to demonstrate the successful integration of computers in schools in the province came on the heels of the Ministry's provision of extensive funding of microcomputers over the previous five years. The public (and indeed the government) were demanding accountability from the Ministry. Were the huge sums of money for computers being *well* spent? How successfully could computers be *integrated* in schools? Were there *really* applications for computers in curriculum areas other than writing, business, mathematics, and computer programming?

By targeting select schools, the Ministry hoped to address these concerns and demonstrate the effectiveness of the computer as an instructional tool. To facilitate the process, it offered the incentive of a $100,000 (Canadian dollars) computer grant plus an additional grant of $70,000 for peripherals, staffing, and related expenses to each of the six regions of Ontario. Interested school boards were to submit proposals to the Ministry, which would then select one school from each region. These schools would then be "computer-rich" and would be at a hardware-availability ratio several years ahead of normal. Thus they would be in a position to determine the real potential of the computer for education without the distractions of "not enough equipment," "not enough support," and so on.

1.3 Quinte School as a Lighthouse School

With only a two-week deadline, the Hastings County Board of Education presented its proposal to the Ministry of Education for the establishment of Quinte Secondary School as a site for one of these pilot schools. The Ministry selected schools to produce a cross-section of schools, elementary vs. secondary, public school boards vs. separate (Roman Catholic) school boards and English vs. French language schools. The Hastings County Board of Education's choice of Quinte Secondary School offered an English speaking secondary (high) school. Furthermore, the submission by The Hastings County Board of Education was to focus on all curriculum areas while other projects took a much narrower focus.

Quinte Secondary School was chosen for two key reasons. First, the principal was highly motivated, had been a great advocate of change in the secondary school, and had a record of being a strong supporter of staff wishing to try new ideas in education. She was instrumental in establishing the county's first adult secondary school programs complete with child-care facilities in his previous school. Second, Miss Susan Catherwood had already demonstrated her strong motivation and commitment to furthering the use of computers in the school. As well, she was held in very high regard by the staff. This

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latter fact was to prove very instrumental in the ultimate success of the project. In all other ways the school was very typical. Computers were presently playing a very small role in business and computer studies. Their use was nonexistent in other curriculum areas.

1.4 Staff agreement

A prerequisite for our board and myself presenting a submission to the Ministry was the agreement and endorsement of the staff at Quinte Secondary School to play an active role in the project. We felt that without their prior endorsement of the project, we would have a much harder time implementing the many ideas we had in mind. This endorsement was given by the staff and we went ahead with the proposal. In fact it is a good implementation strategy to offer substantial resources to teachers or schools on a proposal basis as it requires the group to take effective ownership of the project. It becomes *their* project, not someone else's.

1.5 Goal of the project as outlined in the proposal

The project would demonstrate the integration of computers into virtually *all* areas of the Ontario high school curriculum using Grant Eligible Microcomputers (GEMs) and Ministry-developed OESS software (Ontario Educational Software Service). The proposal described a very ambitious project that would involve nearly every teacher and student! Teachers speculated ahead of time as to how they saw the computer fitting into their subject disciplines. However, as most of them were not computer literate at the time, this proved difficult. Being more knowledgeable of the software, we included in the proposal summaries of how we anticipated the software would be used. We also included a three-phase deployment plan of hardware where we would attempt to determine the best combination of large labs vs. small labs vs. distributed computers. Obviously too, the nature of the goal meant that teachers would become computer literate themselves, as well as expecting the same of their students over the one-year span of the project (later increased by half a year.)

1.6 Context

Hastings County is medium-sized (for Ontario) school board with eight secondary schools and 40 elementary schools and an enrollment of approximately 19,000 students. Quinte Secondary School is one of the larger schools, but due to a decline in the overall student population in Ontario, currently has only about 900 students. There are about 60 teaching staff members with a principal and two vice principals. Computer use in the county is supported by one computer consultant (myself) with two software/network technicians and three hardware technicians (although during the actual Lighthouse project there were only one software and two hardware technicians.)

2. Organization of the Project

2.1 Personnel

The project was overseen by the Board computer consultant (myself) who provided staff inservicing, arranged for outside inservicing and was a liaison with the Board and the Ministry. Approximately one third of my time was devoted to the project during its duration as I still had my other functions as consultant to all the other schools within the Board to fulfill. My time was provided by the Board.

The project was coordinated within the school, on a full-time basis, by Susan Cotherwood, a math teacher who had been the computer site administrator for the past few years. Susan provided much of the day-to-day inservicing for other teachers and students. Susan's salary was paid for by the project, but because she was replaced by a teacher with very little past experience there was a cost differential that allowed us to hire one additional person, Deborah Gallinger. Miss Gallinger was a technical assistant hired specifically for the project. She assisted full-time in network management and inservicing. Several students assisted in the project as co-op students—an arrangement that allowed them to earn school credits by assisting teachers and students in the labs.

Susan and I met almost daily, discussing strategies for teacher involvement and trying to iron out problems with hardware and software, which were many. (Such are the rewards for being on the "bleeding" edge of technology.)

2.2 Physical facilities

Before the project started, the school had a computer studies lab of approximately 20 ICON computers with a 65 Mb fileserver and another small lab of 10 ICONs with fileserver that was used by a relatively small number of teachers and students. The infusion of $100,000 from the Ministry added 25 more ICONs and one more fileserver. More funds from The Hastings County Board of Education brought the ICON computer complement to 63 with 4 fileservers (all with 65 Mb hard drives). Over a period of several months, the four independent ICON networks were gradually combined to produce one large super-network by April 1988. This required extensive rewiring (aided by UNISYS) and the addition of seven network expanders—intelligent signal retransmitters with built-in diagnostics.

In addition to the ICON system, there was a lab of 18 IBM computers (with fileserver) in the business department although these were not considered to be a part of the Lighthouse Project per se. Peripherals included numerous printers, a plotter, modems, midi interface and keyboards and rhythm units, a hardware-based screen broadcast network for 20 stations, as well as a standalone PC with a CD-ROM.

2.3 Deployment

The original plan called for the development of three computer labs with approximately 20 ICON computers in each. (This does not include the IBM lab at all.) The remaining computers would be placed in rooms with one or two computers only. After a period of approximately three or four months, one of these labs would be broken up and the computers distributed into individual classrooms according to teacher and student needs. Virtually all rooms had been wired with network cable, so they were ready. After another period of three or four months, we would create three small labs of 12 to 16 computers plus one larger one of 20. We wished to determine the ideal configuration for a school. The reality, however, for the entire year and a half that the project ran was that we were unable to change from the preliminary configuration of three labs.

The key feature appeared to be teacher readiness. Since one lab was almost entirely occupied by computer studies classes, there was considerable demand on the other two labs. Teachers wanted to be able to go to the lab with their entire class, and additionally, be certain that there would be someone in the lab to provide assistance. Because of this, they were unwilling to allow one of the labs to be broken up. They were also not yet ready to have a computer in their own room. Part of the reason for this was that there was pressure from other teachers to keep the labs intact, and so if an individual teacher got a computer in his or her own room, they would feel obligated to ensure that it received continuous use.

One teacher in the English department adopted the use of computers very readily and was very insistent that computers be placed in her room. She received considerable opposition from other members in the department who felt that they would suffer from the reduction of computers in the lab if she were in fact to get computers. Ultimately, however, we did move three computers into her room where they received extremely good use. More will be discussed about her success later.

3. Teacher Involvement, Inservice, and Support

3.1 Inservice

In the spring of 1987, inservice workshops had already begun even before we received word of the success of our proposal. These after-school workshops tended to be awareness sessions on the use of the operating system's user interface and familiarization with the word processor. Most teachers were not computer literate and had not used word processors before.

Later in the spring we invited the developers of various software to the school to run full-day workshops for selected staff. Where the focus of the workshop was narrow (e.g., chemistry), we invited teachers from other schools to attend. The developers' extensive knowledge of the intricacies of their own software, and their understanding of its intended use was invaluable.

A negative aspect of this type of inservice, however, can be that often the developers are not teachers and as such may not understand the dynamics of a class full of teenage students or have a knowledge of the goals of the curriculum. This tended not to be a problem in our workshops as most of the developers that we invited were in fact teachers before they became software developers. Many were still actively teaching.

3.2 On-going support

Being able to see the power and usefulness of the software provided the "hook" that was needed to excite the teachers. They then required a considerable amount of hand-holding while they reverted back to their low level of computer use. To make teachers as comfortable as possible, workshops were conducted in small groups of five and ten. This allowed for more personalized attention and imparted the feeling in teachers that they were not alone in the inservicing and would not be left alone when they took a class to the computer rooms.

It was very important that teachers receive rather prolonged support in labs with their classes. It takes a long time for teachers to gain the confidence needed to literally place their trust in the computers. There was always the fear that something would go wrong, and in fact, it often did! We tried to keep the hardware problems to a bare minimum, but the unexpected does occur. The hardware experimentation that was going on was interesting for us and the hardware suppliers, but it would have been much better for the staff to have been operating in a tried-and-true hardware environment.

3.3 Strategy for inservice and teacher support

Our goal was to provide as much support (hand-holding in some cases) as necessary and then gradually begin to pull back. This often took the form of moving from having Susan in the computer room with the teacher and class to having the network technician in the room. Later on, as a teacher's confidence grew, only a co-op student would be there, and eventually the teacher would be on his or her own.

The process of initially getting teachers into the labs to use the computers was accomplished by convincing them of the benefits of computer simulations or computer-assisted instruction and promising a lot of support and also by cajoling or lightheartedly browbeating them into agreeing to try the computers.

Teacher inservice continued on a more individual basis as they approached sections in their course where they saw that the computers could be used. Susan would spend several periods with them going through a program, talking about how it operated and how they might integrate it into their lesson plans. We had told the teachers that we would always have one of us in the computer lab with them when they brought in their class and that after they had used the programs several times we would have the technician in the lab if we were unavailable.

This ongoing support was critical in reassuring the teachers that they were not going to be left in the lab alone.

3.4 Individualized guidance

As new software was released for a particular discipline, we would sit down with the appropriate teachers and walk through the program, showing them what it was capable of doing and asking them how they might use it with their classes. We gradually placed more ownership of the software with the teachers. We wanted them to eventually take control of their own professional development and inservicing.

3.5 Substitutes

As much as possible we tried to release the teachers from classes by hiring supply teachers. It was one of our goals to avoid "adding on" computer time to teachers' already busy schedules. In fact, virtually every teacher received at least one full day off for inservice. This meant a substantial expenditure on substitute teacher coverage was needed although overlaps reduced the number considerably. The money for this was part of the project expense. It is a major cost factor in the introduction of computers in education, although many school districts tend to use their available money to purchase hardware rather than inservice release time. There is considerable evidence now that this is changing, probably due to the presence in schools of computers that aren't been used (or at least not properly).

The knowledge that the project had a definite time frame to it (one and a half years) meant that the extensive support would come to an end. We had to ensure that the teachers reached a skill and confidence level that was high enough to allow them to continue to make effective use of the computers after the support was no longer available. We also hoped that they would be able to solve minor hardware problems by themselves since the resources of a fulltime network technician and site administrator would cease at the end of the project cycle. Had we been using industry-standard hardware (DOS or Mac), we might have had more success with this aspect because the likelihood of the teachers purchasing their own computer at home so that they could also use the software there would have been much higher. This past year, many did purchase DOS computers, lamenting the fact that the ICONs software is not DOS compatible and underscoring the need for standardization in the industry (which through attrition is now occurring.)

4. What's Happening

4.1 Student writing

Students began their inservice in September with a short one-period "survival" course on word processing by using the Ministry-supplied program "WPro" by Klondike Software, Ottawa. This program is menu driven and requires very little training in its use although word processing in general does, of course, require an understanding of basic concepts such as blocking, search and replace, and file management. Students were brought into the lab in groups of 15 and trained in about 35 minutes. This gave them sufficient skills to be able to use basic functions of WPro enough to create, edit, print, and save their writing assignments. Staff agreed to require a certain number of assignments done on the word processor. This produced a crunch at exam and report card time as students rushed to get into the lab to get a computer to finish their last-minute jobs.

Most students took to the computers immediately. While some students had some exposure to computers in elementary school or at home, most had not. However as has been noted in many other studies, students do not have a fear of new technology or any hesitation is using it—understandable since they have been surrounded by it since they were very young. They didn't go through the stage of wonderment that some of us did when the pocket calculator replaced the slide rule!

The most notable achievement for students was the improvement of their writing. Analysis revealed a definite increase in the actual *quantity* of writing and an improvement in the *quality*. (Unfortunately quantitative data is not available for this paper as the Ministry required qualitative data only.) The ease of editing on the computer both allowed and encouraged the students to edit and revise their writing. Furthermore, the improvement in legibility in printed output allowed the student with poor handwriting to produce writing that was as good looking as his or her peers'. Spelling mistakes were more easily spotted, and since it was so easy to make alterations, the students changed their writing until it was as perfect as it could be.

4.2 Writing and the lower-functioning student

The interaction and participation of students in Basic Level classes (lower-functioning students) improved. Students tended to work in pairs at computers and helped each other in their work. This was an unusual and surprising effect of the computers. It also appeared that the defensiveness that students used to feel toward their written work did not exist while *the writing was still on the screen*. It appeared to be still "in flux" and not "finished" until it was actually on paper. It encouraged perfection—a quality of work not normally associated with this group of students. The pride of workmanship was evidenced in these students' willingness and even eagerness to actually read their work out loud to the rest of the class. To have attempted this before the use of word processors would have been like trying to pull teeth.

4.3 Keyboarding

The question of keyboarding skill was not much of an issue with the lower-functioning students as the total amount of time taken to produce a piece of writing was about the same if they had to write it carefully enough to be handed in. However the problem of key-

boarding speed was significant at first in the general student population. There was an increase in the number of students enrolling in keyboarding courses the next year (partly based on our encouragement). However, generally speaking, students became quite adept at "hunt and peck." A brief visual survey of students showed that most of them were using two or three fingers on each hand, not just their index fingers. While a program for developing keyboarding skills was available, it was not used very extensively except in the keyboarding courses.

4.4 More observations about lower-functioning students

Programs for remediating literacy and numeracy were used extensively and successfully for students in remedial/withdrawal sessions in a resource room with three ICON computers and a printer. Resource teachers felt that the "fun" and" 'friendliness" of the computers and software motivated these weaker students more than teachers' normal methods and materials. Thus the sessions tended to accomplish more because the students were on task more often. The increased motivation often lead to interesting spinoffs.

One student who was functionally illiterate and almost noncommunicative began to spend extra time at the computers in the resource room exploring BASIC programming of graphics. He watched students at the computers in the labs and began to pick up techniques that he ultimately mastered. Within the year, he had become one of the most knowledgeable students in the area of programmed graphics. This led to a marked increase in communication with other students and a much more positive self-image. He began to communicate freely with teachers and about one year later got a job at a local computer company where talking with customers was part of his job. That was a position that none of his teachers would ever have thought possible two years previously.

4.5 Science

While word processing applications dominated the use of the computers, many simulations and tool programs were also used. These programs were produced in Ontario to match Ontario curriculum. "Electric Chemistry Building," a powerful chemistry simulation, for example, allows students to select materials from a storeroom of chemicals—both inorganic and organic. By selecting certain groups of chemicals and apparatus, students make observations of the reactions of those chemicals under controlled conditions. Individual variables can be manipulated, allowing the student to understand the effect of each variable of the outcome of the reaction. Titrations are performed, varying the quantity and concentration of acids and bases, and the speed at which the reagents are released from the buret. The student controls all of these variables and performs the titration until the indicator shows the end point.

Besides allowing control of individual variables, the simulation allows the student to conduct experiments which are too dangerous to conduct in a real setting (nuclear reactions) or that are too expensive or difficult to perform. An example of this would be a simulation of the Haber process. A sample experiment for this involves the student finding out the effect that that an increase in pressure has on the production of NH3 from N2 and H2. The student manipulates the graphics on the screen to set up a piston and a heater and then places .2 moles N_2 and .2 mole H_2 in a piston, sets the temperature to 500K, equates the gas pressure to applied pressure by applying a pressure of 101.3 kPa, and then finds the concentration of NH_3 in the system. He or she would then increase the gas pressure by 100 kPa increments and find the amount of ammonia in the equilibrium system for each pressure. After making observations and plotting the pressure vs. ammonia concentration, the student would then answer the question in the original objective. This experiment simply cannot be done in a school lab, and the chemistry teacher reported that this was the first time he had been able to successfully demonstrate the process.

The use of simulations in the chemistry lab is not only important for performing dangerous or expensive experiments, it is a realistic reflection of industry where computers are used to run potentially dangerous simulations first—before being done with actual chemicals. This latter fact came to be appreciated by the chemistry teacher after working with the software. It should be noted that prior to the project he felt that there was no substitute for hands-on experiments with real chemicals. He now recognizes the very important role that simulations can play and used the computer to run other simulations to verify or predict results that are attempted with real chemicals. Thus the software has become an integral part of the teaching strategy for chemistry.

Students found that by performing the experiments ahead of time on the computer (where possible) they would have a good idea of what results to expect (e.g., how much acid to add in a titration to reach an end point). This gave them greater confidence and reduced the number of retries that they would have been required to perform.

Other simulations allow the student to replicate experiments that might be done in school but that the students may have missed due to illness. In physics, the software *Let There Be Light* stimulates an optical bench with convex and concave mirrors and lens and light sources. The curvature of the lenses and mirrors, refractive indexes of the glass, and distance and type of light source are all variable. The students can set up the optical bench and see the effects that each variable has on the bending or reflecting of light. A physics teacher however commented that this program did the "easy part" and that "it stopped just before the hard stuff." The

program in fact, demonstrates light reflection and refraction admirably but does not explain for example, why refraction occurs in the first place. (On the other hand, neither would a real life experiment—it would still be the teacher's discussion of the topic that would bring out the reasons.)

4.6 Math

The use of mathematical equation-graphing programs (particularly *Functions Workshop* and also *Intuitrig* to a lesser extent) allowed students to plot complex equations immediately. Previously students would typically graph three or four equations only. Most of their time and effort would be placed in producing a good looking and accurate graph. Much less time would be placed on interpreting the graph. The repeated graphing on the computer allowed the students to change parameters easily and see the effects on the curve. This led to a better understanding of the mathematics involved. The equation and its components are the focus, not the "prettiness" of the graph. Math teachers did observe an increase in the level of understanding of functions after using the software. It might be noted here that part of the reason for the success of the math teachers may have been because of Susan Catherwood's math background and the teachers' high regard for her knowledge. Nevertheless, the math teachers continue to use *Functions Workshop* as an integral part of their teaching of functions.

4.7 Social sciences

In the social sciences, a problem solving/decision making simulation called "Decide, Your Excellency" has the student taking the role of a ruler in a developing nation. Various social, economic, political, and geographical factors as well as other individuals affect the economic well-being of the country. By interpreting data that is generated during the simulation, the student must make decisions and develop a strategy necessary to gradually improve the quality of life in the nation. This very powerful program requires at least five hours to do properly. This time would involve student instruction on the educational objectives and expectations and the geoeconomic politics of the country before the computers are even touched. Students would work in pairs or threesomes to improve their decision-making and communication/arbitration skills. They must make decisions understanding the significance of short vs. long term goals and the effects of "popularity." The geography teacher now has this unit written into his course of study and has been quite successful in encouraging geography teachers in other schools to use the program. The most active user of this program has since moved to another school in the district and has interested the teachers in that school also. This is another way that diffusion of knowledge to teachers can occur.

Family studies classes made extensive use of "Food Nutrient Tally" to analyze the nutrition content of their own eating habits and also compared nutritional intakes typical in Canada to global nutrition. The use of this software is now part of a County curriculum document.

4.8 Technical Studies

AutoCAD was introduced to students during the latter part of the project. This came as a result of teachers and students being exposed to a program called *CADTutor*, obviously an introductory CAD tutorial. Use of this program stimulated interest in drafting and other technical teachers. Three IBM workstations were added in the department, each running *AutoCAD* (Version 9). After the Lighthouse Project was officially ended, the Technical Department extended its use of CAD adding more workstations and upgrading to *AutoCAD* (Version 10).

During the past year, the whole Technical Department has undergone a major facelift, focused primarily around a new Philips DOS 286 and 386 computer lab used solely for CAD and CAM. The experiences at Quinte also led to the upgrading of Technical Department facilities in all of the other high schools in the Board. This transformation was initiated by the department head of Technical Studies, Mr. Tony Roehrig, who also works half time in my office at the Hastings County Board of Education central offices as technical consultant. Tony was more or less computer illiterate at the beginning of the project but has now switched over all his classes to CAD and is heavily integrating the use of computers in the machine shop (CAM) and auto mechanics. He has become a driving force in pushing for major upgrading in his area.

5. Effects of the Project

5.1 Observations of staff

A measure of the degree of acceptance of computer usage was illustrated by the change in attitude of numerous teachers from a position of going into the lab reluctantly and wishing computers would "just go away" to the stage one year later when we almost had a revolt in the English department when we tried to take three computers out of the lab to put in one English teacher's classroom. The other teachers in the department felt that they did not want to lose any computers from the lab. Students were using the computers a great deal, and the teachers felt that if the lab got too small it would lose its effectiveness. We were, however, able to get three more computers to go into the one teacher's room where it was used extremely effectively in a basic level (lower-functioning students) class for writing.

Most teachers did rise to the challenge of trying to utilize computers. Once they did use the software with their classes they were usually convinced although they still required support for their later excursions to the

where they would use the computers on their own volition, and the use of simulation software was written into their course of study as an integral section. This was done when they found that the computer simulation provided the *best method* of instruction.

This is, of course, the ideal reason for using computers. As mentioned earlier this level of use occurred more frequently in geography, math, chemistry, and family studies. I believe the best simulations are those that are process oriented instead of content oriented. The Ontario educational community places a high value on higher-order thinking skills. We use content as a vehicle for delivering those skills rather than the other way around. Simulations that involve "what if" hypotheses emphasizing decision making and problem solving are highly useful in educating students and helping them cope in this rapidly changing world.

Other teachers used the computers simply as an alternate instructional method. Still others tended to use the computers as a change of pace method. A few used time in the labs as "reward time" for their classes. This differential reflects, I believe, two things. First and most obviously, the availability and quality of software, but secondly and more importantly, the instruction/implementation level of the teacher. The more comfortable and committed the teacher was to the use of computers, the more likelihood there was of the curriculum being modified to include specific computer use.

A comparison with films and video tape is obvious. There are teachers who use a film because it can do a better job of getting across concepts that the teachers judges valuable, other teachers who use the film as a change of pace—if the film is as good as his or her other instructional methods, and unfortunately, some schools have teachers who will show a film because it is "Friday afternoon," or because they haven't prepared lessons properly, or because they don't know what else to do. Implementation leaders must be careful that computers do not fall into that latter function. Beware the teacher who refers to computers simulations as "games" or talks about letting the students "play" on the computers. Chances are also quite likely that teacher is generally does not have good teaching methodology or commitment.

5.2 Importance of support

Most teachers surveyed during the course of the project felt that the continuous ongoing support they received was crucial—a fact of which most leaders involved in educational change are already well aware. It is also necessary that the teachers be involved and committed in principle before a major change is introduced if a positive and cooperative environment is to be maintained.

That being said, it is also necessary for support to gradually be removed from a high level to a lower level as it is very unlikely that sufficient resources will be available for an extended period of time. This lower or maintenance level of support might take the form of an in-school resource person or a central resource person available on-call for telephone support or visitations. This is the level at which Quinte Secondary School now exists. There is one teacher (Susan Catherwood's successor) available at the school who has only a part-time teaching load and can assist teachers if problems occur. In addition, there is the Board consultant (myself) available for assistance or inservice workshops.

5.3 Post Project Stage—Decline

We had anticipated a drop off in computer use when the project was over. This did in fact occur and was likely caused by two factors. First and expectedly, the focus or attention on the project by educators outside of the school was removed or greatly reduced. Teachers no longer felt an obligation to use computers. Those that continued to use them did so because they were firmly convinced of the merits of computers in education. They needed no outside stimulus. Other teachers slipped back into their former methods of delivery.

The second reason for the decrease in was a change in personnel. Ms Catherwood took a leave of absence to teach in the Netherlands for three years, and her place was filled by another staff member who related to other teachers in a different manner from that to which they had become accustomed. I had to refocus my attention on the other schools who had been feeling (rightfully) somewhat left out. As a result, teachers at Quinte had much less support. Again this was not a problem for the highly motivated and highly committed teachers but rather to the others who had less of a commitment to the use of computers.

5.4 Post Project—Rejuvenation

There then followed a period of rejuvenation about one year after the end of project, which saw the dismantling of one of the cross-curricular labs and the moving of those computers into individual classrooms as single computers or in groups of two or three. Some teachers wanted to use the computers again after a semester of not using them. Others were simply feeling more comfortable about the support that was available. Another factor was the much greater emphasis on DOS-based computers that had grown considerably in the last year. A number of teachers decided to purchase their own (DOS) computers—a step that greatly increases the likelihood of computer use increasing in their classrooms. At the Board level, we began to experience a snowball effect as requests for computer hardware, software, and inservice workshops accelerated. Schools are now using industry-standard word processors and spreadsheets, databases, drawing and paint programs, CD-ROM based encyclopedia and periodical indexes, external real-time measurement devices attached to computers (e.g.,

IBM Personal Science Lab), music editing, and sequencing and scoring software. Libraries are converting to a multi-tasking, multi-user, computer-based catalogue and circulation system with bar coded books and student identity cards integrated with an office-based student information system running on 386/486 based 120-320 Mb SCSI HD computers.

5.5 Post Project—Stabilization

Stabilization might be expected if it were not for the very rapid changes in computer hardware and software that the whole industry is now experiencing. Quinte Secondary School's current enrollment stands less than 800 (although it was built to hold about 1200). With over 130 computers it has a ratio of less than 6 students to each computer. Its computer requirements will be minimal over the next few years and purchases would probably take the form of upgrading of existing equipment.

Many teachers are now self-sustaining in computer use. They use the computers on a regular basis and view them in the proper perspective of simply another instructional methodology to be used only when appropriate—meaning when the computers' use is the best way to get a concept across to their students. The teachers view themselves as responsible for their own inservicing and rely less and less on central support. The goal of a good consultant should be to eventually become redundant by raising the level of expertise of clients to the point at which they provide each other with the ever diminishing amounts of support needed.

Students view computers as a tool. The word processor is used as a matter of course—the normal way of preparing a term paper or essay. Computer use in classes for simulations is no longer regarded as something unique. The "gloss" has worn off and computer use has found its proper place—another way of learning.

5.6 Reasons for success

The project was successful because of many significant factors. A computer rich environment was provided—there were more than enough computers to go around. Software was of a good quality and available everywhere on the network. Students or teachers did not have to be concerned about which computer they logged on. There was a well thought out approach to inservicing. Substantial support was available from the beginning and was purposefully withdrawn later to force teachers to take ownership. It is essential that adequate financial resources be available to allow support personnel time release. To sink large amounts of money on computer hardware and software without providing training and support is foolhardy and guaranteed to produce abysmal results.

5.7 Dissemination

Teachers were asked to document their activities on the computers and write worksheets to be shared in other schools (in fact with the whole province). This provided both internal and external motivation. They became the experts in particular software applications and were asked to present workshops to their colleagues in other schools. The worksheets that the teachers developed formed an addendum to the report to the Ministry of over 100 pages and is currently available from this Board. The worksheets outline exactly how the software was used, where it dovetailed into the curriculum, what preservice was required, and what follow-up ensued.

5.8 Final observations

It is important to note again that the project was not forced on the school or teachers. They were approached about the concept and after much discussion they fully endorsed it. This was crucial to success. There was certainly fear, trepidation, uncertainty, and all the other insecurities possible, but there was never resentment or unwillingness to at least try!

What the project did to the school was remarkable. Teachers were rejuvenated, students were enthused, administrators were proud. The school became a leader in its educational community. Coordinators were invited to speak around the province and even in other continents. One even wrote a chapter for a book.

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Netherhall School-Cambridge, England
Building for the Future on the Experience of the Past

by A.J.Wells[1]

1. Background and Description of the School

1.1 Introduction to the school

The Netherhall School is a coeducational comprehensive school of 1400 pupils who range from 11 to 18 years of age. The school has a teaching staff of 89 supported by technicians, secretaries, and administrative staff. The school is deservedly popular in the local community and has developed a national reputation for its pioneering work not only in writing educational software but also in developing good classroom use of hardware and for integrating computers applications throughout the curriculum.

1.2 Purpose of the case study

This article aims to examine how the use of computers has evolved within the school since they were first introduced in the 1970s, and what our current plans are for the future.

1.3 Current state of affairs with respect to hardware resources

The school supports two 22-machine network rooms, one equipped with Archimedes A3000 and A410 computers and the other with BBC Compact and Master computers. The network rooms also extend to certain areas of the school to link classrooms where the demand is greatest.

The administration offices are equipped with IBM computers, and these are also network linked. Each subject department in the school is also equipped with a computer workstation, usually on a trolley with support peripherals. The latter include printers, plotters, scanners, digitisers, robotics, data loggers, music systems, modems, and teletext adaptors. In addition the school also has six interactive video systems, laptop computers, a variety of colour, dot matrix and laser printers, and a vast software library and support materials. In all the school has over 130 computers with a computer-to-pupil ratio of 1:11.

The computers and peripherals are made accessible to pupils at all times, not only within departments but also in the libraries, at lunchtimes, and after school. No request for an appropriate use of a computer has yet been turned down, and older pupils are now actively using computers to accomplish a piece of course work knowing what the capabilities of the computer are rather than requesting to use a computer to discover what its capabilities might be.

2. First Steps in the Development of the Technology-Enriched Environment at Netherhall School

Obviously a lot has happened in terms of how we use computers since they were first introduced in the 1970s, particularly in the nature of software and hardware and how we train the staff and pupils to effectively use the technology for individual, classroom, and whole school needs. Learning from the past, evaluating the present, and having a clear vision and long-term plan for the future are essential elements for the individual and preferably the management team responsible for ensuring good use of computers within their establishment.

2.1 Establishment as an M.E.P. Software Development Centre

In 1981 the Netherhall School was established as an M.E.P. (Micro Electronics in Education Programme) centre. This was a government-funded initiative to develop software within schools, designed and evaluated within the classroom by teachers and supported by professional software programmers.

When MEP funds became available, the school submitted a proposal, which proved to be attractive, and the bid was successful. The school was known for its use of computers and several members of the staff were active participants in working groups involved with computer assisted learning, and this combined with the fact that not all that many schools at the time were active computer users gave substantial credibility to the bid.

Initially funding allowed us to release four teachers for half a day a week to design software packages in mathematics, geography, physics, and biology. In 1981 students were used to program the packages, and as time went by the software we were producing proved to be popular and the team grew so that it became its own unit—"Netherhall Software"—with a director, secretary, four professional programmers, and a team of teachers encompassing a greater number of subjects including history, English, and special needs.

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[2] Note: The headings and divisions in this chapter differ from those in the other case studies, in that the case of Netherhall School is not that of a school currently involved in a TES project, but rather is the case of a school evolving over time through a variety of TES-like projects and in the process becoming very much a technology-enriched school. We felt the addition of one case study looking at a TES school from a non-TES project perspective would be interesting for comparative purposes. Because the case study tells of the school's evolution through a variety of projects, we have let the author tell his story using a different organization than that which we asked of the other authors.

At the time the school had approximately 30 computers and 12% of the staff were classroom users of this resource.

Many of the teachers involved with Netherhall Software in the early days remain on the staff, and during the MEP period they developed skills in design, research and evaluation of software, hardware, and the use of computers and teaching strategies within the classroom. This expertise has remained available to integrate imaginative uses of computers within the classroom today and to provide a team spirit in terms of a vision and strategy for the future.

2.2 Pay-off of software development projects

The MEP days were an invaluable starting block as the teachers involved often worked with their own packages in the classroom testing, evaluating, and modifying them as they went along. The software being developed was often simple, but to be simple and successful, the software needed very careful design and error testing. The pupils and other staff soon exposed difficulties in understanding instructions and how best to use the software, so a strategy for developing software soon evolved. A paper specification was first analysed with both subject and nonsubject specialists.

> What was the software package trying to do? Could the exercise be accomplished more efficiently or better in other non-computer ways? What would be the pupil experience at the keyboard? How will the teacher interact with the pupils and the computer? What are the outcomes? How can the software be used in different ways and for different age groups?

These were just a few of the basic questions the team had to address, and from this came successful software with a support booklet illustrating how to operate the software, suggestions of how the program could be used and managed in the classroom, and even worksheets for pupils to use. In other words, the teacher was provided with a complete application that could be taken into the classroom and used.

Today many of the content-free software packages fail to do this and rely on the teachers having the expertise to manufacture good applications for themselves from an array of much more impressive or daunting hardware. Most teachers have not yet reached this level of expertise, and although the pupils have an open mind in the use of such setups, it is the teachers who are directing the learning program within the classroom, and they need a knowledge of the capabilities of modern computers in order to let their pupils blossom from the experience. They need not be competent users of the computers, but they do need to be facilitators. If they can be shown how to use Desktop Publishing or spreadsheets in their subject area, they will, given some degree of training, encourage the use of software by directing the pupils to activities that would benefit from being enhanced on a computer, and they would understand the outcome and be in a position to advise their students on the next step. There is no point in a teacher using computers with students who largely direct their own learning at the keyboard, and at the end of the lesson complement the students on their activities and close the door when they leave. There must be interaction and a sense of purpose in what is being achieved between student and computer, teacher and computer, and student and teacher.

2.3 Other pay-offs from initial project experiences

The MEP days provided an important foundation for the use of computers in the school. Teachers became aware of their value at a simple effective level and certain members of a select number of departments could share their experience with other members of their departments. The result was a slow introduction and diffusion of what was then called Computer Assisted Learning (CAL), and there was no pressure on other colleagues to use computers unless they wanted to. Software was only introduced to teachers when a good program had been identified that would appeal to the user. We learned very early that showing clever pieces of software that were not particularly relevant to teachers, or if what was being demonstrated could easily be achieved by other means, only provided the nonconverts with ammunition against the successful introduction of computers. The focus was therefore concentrated on the willing, often younger members of staff who were willing to experiment with new technology. This often resulted in a much better rapport with students as these teachers were seen to be modern and have exciting and imaginative lessons. In other words, right from the start students had gravitated to the use of computers in their lessons feeling no animosity towards the hardware, which was not always the case with the more apprehensive teachers.

It is probably worth noting that in this early period "computer studies" was a subject that pupils could opt for and was largely taught by members of the mathematics department. In many schools the introduction and use of computers was dominated by mathematics teachers who saw it as their domain. At this time we also only had one BBCB network room and most lessons taught in this room were mathematics and computer studies. There was, however, a very positive attitude toward allowing other subject areas access to this room when the MEP team was set up. The room was made available for all subjects to book as they needed it, and much of the early software testing took place in this room. CAL became everybodies' domain, and the computer room was seen as a shared resource. Computer studies was given its own room to make the main network room as available as possible to the other

departments. This philosophy proved invaluable in that it opened the way for cross-curricular projects and a willingness to share resources, vital when it comes to the allocation of funds, which in the case of computers is usually expensive and at a cost to others in the school.

3. The Next Phase: Emphasis on Teacher Training

How then did we quadruple the number of computers in the school from about 30 in 1981 to the present day? First it is important to look at how things progressed from the early days and the building blocks or stepping stones that we provided to ensure a progression in the use of computers in the school.

3.1 Concentration on inservice training

The next phase concentrated on Inservice training ("Inset") of staff, building on our classroom experience. We soon had established workshops for different subject areas and this soon extended to training staff from other schools, subject working groups in the area, and student teachers from local colleges of education. The school rapidly developed a reputation for expertise and good practice, and we were soon receiving many visitors, which have included ministers and inspectors from the Department of Education; ministers for education from other countries; and visiting computer eductionalists from many countries such as Japan, Australia, Canada, India, Sweden, Holland, Denmark, and Egypt.

3.2 Need to increase facilities

Momentum was now gathering, and access to computers was becoming increasingly important. We needed to extend the use of computers around the school, and departments were actively encouraged to buy what they needed from departmental funds. Naturally sufficient funds were not always available, but several departments shared the cost over two years. In the first year, they shared the cost of buying one workstation, usually a computer with monitor, disc drive, and printer. This workstation was shared between them for the first year, and this gave them time to experiment and find the best use of the computer in their departments. Sometimes one department felt the introduction of the computer was too soon, and they were not ready to take on the new technology. In this case the other department bought the half share of the workstation outright. In most cases, during the second year a complete new workstation was purchased, and both departments had their own setup but because of the shared nature could still borrow the other one when it was needed. This sharing remains today and quite a lot of equipment is moved to where it is needed for set periods of time to maximise the use of hardware in the school.

Clearly a positive attitude to funding hardware was important from the start, and the Headmaster and senior management team have always had, and continue to have, a forward vision of the need for more computer resources in the school. The Headmaster has allocated funds in several years to specific computer developments, and departments have had to submit their bids for equipment. These funds have provided important injections of equipment to departments and acted as a stimulus and motivator for the use of computers.

3.3 Administrative expansion

In the early 1980s, software developments extended beyond the classroom environment, and database work began in the administration offices producing classroom lists and room timetables and soon, exam lists. Experiments were carried out on pupil profiles and reports, and word processing was introduced to the office staff. Today the administration offices are equipped with IBM computers, and the office staff deal with many tasks associated with the electronic office such as desktop publishing, finance, ordering, stock taking, pupil lists, electronic mail, and so on.

3.4 Start of cross-curricular projects

The team of staff responsible for designing the Netherhall Software now had colleagues willing to experiment with new software packages, which had been brought in for use within the school. This was the start of using content-free packages such as databases and spreadsheets to support the subject-specific software that was being purchased by departments and was also the start of cross-curricular projects within the school.

Netherhall Software now had its own office within the school grounds and this provided a library of materials for teachers to view and use. This library was another asset in developing good use of CAL within the school, and the offices provided a good environment to develop teamwork and projects.

The first cross-curricular activities often occurred between two departments sharing resources and a common theme of study. As time went by more adventurous projects were initiated often between four and five departments with a project based on computers lasting three to four weeks for the pupils involved.

These projects were often firsts and many outside groups that had previously been involved with the school were interested in seeing the projects in action and those who could not make it were interested in the projects being documented. This happened, and several of our cross-curriculum projects have been used as exemplars in books, magazines, and training documents over the years. Again this helped to give the school a high profile, and teachers that were involved in these projects made important contacts with influential groups.

3.5 Evolution of "Netherhall Software"

In 1986, government funds for the MEP projects were ceased, and it was up to the individual software houses scattered throughout the country to make their own profits and survive. Many did not and educational software developments took a step backwards. Netherhall Software had by now become attached to Cambridge University Press, who marketed the software that was developed in the school. In order to survive, the team became an in-house software unit for the publishers, and Netherhall Software ceased to be an entity.

4. Start of Interactive Video Projects and Partnerships

4.1 Netherhall School becomes a trial site for a Department of Trade and Industry project

One such contact made during this period was with a team working for the Department of Trade and Industry-funded Interactive Video in Schools (IVIS) project. After discussions with the school they decided that they would like us to be a trial site for IVIS, as they felt the necessary experience was available for good feedback and classroom use of what was then relatively sophisticated equipment needing a reasonable degree of experience to maximize its use. In 1986, we were equipped with an Interactive Video (IV) workstation and began classroom trials.

The equipment was enthusiastically received, and the students were involved ir. developing materials as well as the teachers. As a result of classroom experiments several good applications were developed, complimented by support materials and worksheets. These are now used regularly by the departments who developed them and new materials are constantly being produced. However, there was some frustration that the software supplied to control the IV systems was limited, and teachers and students were soon asking if they could control the IV in much more imaginative ways. Using the experience of the Netherhall Software days, we selected two skilled students and put them to work on developing some new software that was designed by teachers. Very soon several exciting packages had been developed and shared with other schools who also had IV systems. Again this heightened our profile, and it was thought that a second IV system should be installed in the school. This gave us greater flexibility, and the IV workstations were set up in the classrooms with departments taking on the task of trialling and developing materials.

Many schools were not sure how best to use such equipment in that it had been issued to them with only guidelines and a demonstration of how to operate it, and then they had been told to try it out and develop some instructional ideas. Only a small percentage of the 90 schools set up with this equipment were able to cope as they had not had any stepping stones of experience to fully utilize such equipment. As a result the impetus of introducing IV to schools diminished despite its being an excellent and powerful resource. Many school were also using "Domesday" IV systems and were experiencing similar frustrations. If only they had been given content-free software developed by teachers rather than dictative software that locks them into certain avenues of inquiry, the influence of IV in schools would be much greater today.

4.2 Building on the experiences of the intervideo project

The experience of IV in schools can be used as a guideline for the introduction of other technologies such as CD-ROM and multimedia systems. If the hardware is put into schools without curriculum support materials, its success is going to diminish after the initial excitement until sufficient support materials have been developed for different teaching styles and different age and ability ranges and the momentum can be picked up again to revitalise the use of the hardware in question.

Here at the school we are still developing software for controlling IV and have extended its use into a multimedia package. We are currently developing this into a full curriculum application, but the important thing to note is that as experienced users we have taken six years to reach this point. Evaluations of such hardware often occur within the first two years and to an outsider very little may have happened. However, within the confines of normal teaching, inservice training programs, time, funding, and the mixed levels of skills and experiences of teachers and students, six years is a relatively quick period of time to infiltrate the use of such technology throughout the curriculum.

This has been confirmed in my role as County support teacher for interactive video. For the last two years I have been seconded for one day a week to help twelve schools in the area maximize their use of interactive video. This support has proved invaluable to them, and I have been able to give them inservice training, new software, support materials, directions on classroom use, and strategies for effective use on their school. However, one day a week for twelve schools is only of limited use and a greater support mechanism of a highly skilled classroom user is needed for any specialized hardware system. Ideally this would be for three days a week, maintaining classroom contact time for the other two days.

Having taken on this particular role, I was able to forge even more contacts and specialise in this area of technology with the result that I established a network of contacts that helped me to redistribute and purchase IV systems for other schools as well as Netherhall. We now have six interactive video systems, four being purchased independently by departments within the

school in addition to the two supplied as part of the IVIS project. They are used in a variety of areas such as biology, geography, modern languages, geology, physics, environmental studies, mathematics, drama, history, and design technology. We have also built up a library of laser vision discs that can be borrowed by departments together with a laser player or IV workstation whenever they need it.

5. Next Phases in School Adaptation

5.1 New approaches to sharing and planning

We have found that it is not always the best use of sophisticated hardware to have it sitting in one environment all the time largely because the use of computers within any department usually occurs as a burst of activity at a particular time. Such bursts can be mapped by the Head of Department as departments usually follow a set syllabus in each year group and can say when they want to use certain items like interactive video or CD-ROM. This in turn increases the accessibility of the hardware to other departments and promotes the atmosphere of sharing resources and developing cross-curricular activities, which also enable students to adapt the use of computers to their own needs and projects that they are studying.

We have also upgraded equipment, where appropriate, so that the laser players can be used with the very latest computers and software. This has also been another important aspect of continuity in the use of hardware in the school in that we aim to upgrade equipment and make it as compatible as possible with other systems around the school.

5.2 Need for a new round of teacher training

By the late 1980s the use of computers in schools had diversified so much from traditional CAL that additional factors such as the power of new computers and peripherals to take into account text, sound, graphics, communications, and so on, and apply them to different types of use became dominant and Information Technology became the all-encompassing catch phrase. Teachers were always wary of the use of jargon associated with computers; thus "Information Technology" or IT needed explaining.

To overcome this we introduced IT to the whole staff on a training day. Thirteen workshops were organised and staffed within the school covering all the elements of IT that we could offer at the time. These included music, desktop publishing, electronic mail, interactive video, word processing, art graphics, computer-aided design and robotics, spreadsheets, databases, teletext, and others. Staff selected their preferences and were allocated places in the workshops that ranged from one hour to half- and full-day sessions. The exercise in many cases introduced new technology to staff, gave them the opportunity to become skilled users of easily operated equipment like teletext, encouraged them to find out more, but most importantly raised their whole awareness and understanding of the meaning of IT, particularly for the less motivated teachers. The day was a success and achieved its aims with many followup plans being instigated within individual departments keen to benefit and build on their experiences of the day.

5.3 Technological support for instructional innovation

We now pursued a course of equipping computers with peripherals that extended their use and made them more attractive to departments. The geography department was equipped with a weather satellite system and because it was the first in the area we were able to secure a substantial discount from the company involved, as good publicity was attached to the deal, and they knew that the system would get good exposure. The satellite monitor that downloads a live NOAA satellite picture several times a day was placed in the front entrance of the school for everybody to see and use during lessons and at break and lunchtimes. In addition cables extended to the geography rooms where the same pictures could be viewed on classroom televisions.

In other subject areas similar set-ups were established. For example the music department was equipped with a computer, midi sound system, and keyboard. The Design Technology department was equipped with robotics, and the libraries with computers and teletext adaptors.

5.4 Evolution of a school hierarchy for decision making

Funding for this equipment came from the departments themselves who used their annual allocation of money to buy the bulk of the equipment but were also supported by money from the Information Technology department. In other words, because of their raised awareness, staff knew what they wanted and were often directed in certain directions by my recommendations and financial encouragement where I offered a 50% funding incentive if they went ahead. This developed an element of healthy competition between departments who vied for the funds I had available. This was no bad thing as it focused their attention on their IT needs and offered them a ready source of advice that was also capable of coordinating resources throughout the school; in other words, a hierarchy had evolved.

5.5 New acquisitions and organization for technology

By 1989 the school had approximately 75 computers and supporting peripherals, and there was clearly a desire and momentum to obtain more. Approximately 35% of the staff were classroom users of this resource.

At about the same time the government offered schools hardware incentives, the most important of

which was the chance of buying four 32- bit machines for the price of two. Additional funds, which were made available from the Headmaster, ensured that we were able to accept the offer that was subsequently repeated the following year.

During 1989 it was obvious to us that we clearly needed a second network room and this happened to coincide with a new building program within the school and the subsequent reorganisation of rooms. A room became available and funds had to be raised to redecorate and equip the room. The Headmaster was able to fund the decorating, wiring, and some furnishings, but we invited local companies to assist with equipping this new facility, offering them access to bring visitors and to photograph and use the facility for publicity.

We are very fortunate to have Acorn Computers very close to the school, and over the years we have forged strong links with the company testing equipment, helping with publicity events, and supplying photographs and curriculum ideas. Some of our staff have also left the school to work for the Company in Cambridge. The Company was a major contributor to our needs and supplied us with ten compact computers and six A3000 computers and substantially discounted prices. A computer furniture company also agreed to substantial reductions for installing benching in the room, and a parent governor (i.e., school board member) assisted us with discount antistatic carpeting and blinds. We network wired the room ourselves and for about $10,000 (US dollar equivalent) we equipped a new area of the school with a eighteen-machine network room. This has now been added to and is equipped with 22 machines, an interactive video workstation, teletext, and an electronic mail facility. This was a relatively low budget sponsorship in that the school provided half of the funds, and a much bigger sponsorship deal could have been aimed for.

6. Netherhall School Responds to Changes in the National Curriculum

Accessibility to the network rooms for many departments now increased dramatically, and we were faced with the need to plan the use of rooms more efficiently. This coincided with major changes in the education system, notably the introduction of General Certificate in Secondary Education (GCSE) courses, which replaced the two-tier ordinary 'O' level and Certificate of Secondary Education CSE exams, and the introduction of the National Curriculum. These initially caused a loss of momentum in the use of IT in schools, as teachers were heavily involved in planning new courses and materials, and they were attending many meetings and training courses related to the new syllabi. Time was precious, and the excessive time usually needed to learn how to use a computer and software package was just not there. However, this period did prove valuable in that it allowed us to take stock of new developments, assess how best to use our own equipment, and formulate an Information Technology Policy for the school that would be a part of the whole School Plan for the future. This took account of Inset, software and hardware needs for the future, new technologies, capabilities of systems, departmental needs, the inputs and outputs of using IT for staff and pupils, and the processes by which these can be achieved and also to identify specific targets and programs of study that would cater to good use of IT throughout the curriculum.

6.1 IT in the National Curriculum

IT occupies two important niches within the National Curriculum. First it is an important element within the foundation subject "Technology," but perhaps more importantly it is the only true cross-curricular element of the National Curriculum, in that all subjects have IT specified within their documents. This means that whereas in the past we identified suitable teachers, subject areas, groups of pupils, and projects to develop IT across the curriculum, we are now faced with all pupils and all staff having to teach IT in all of the years throughout the school.

6.2 Coordinating IT experiences throughout the school

The result has been very careful curriculum mapping and detailed discussions with departments to find their needs in terms of software and hardware and to encourage them to pursue new strategies to allocate money for maintaining equipment and for purchasing new materials, discs, computer paper, printer ribbons, and so on, which had previously been provided but would now be used in such large numbers that a whole new pattern of thinking had to evolve. This then formed the basis of departmental policies and a new enthusiasm and momentum from the staff to learn how to use IT for their subject—largely because they now realised that they had to learn in order to at least facilitate the use of IT in their lessons.

6.3 Participation in the "TVEI" Initiative

Fortunately at the same time as the introduction of GCSE and the National Curriculum, we had the introduction of the "Technical and Vocational Education Initiative" (TVEI). This was launched by the Prime Minister in 1982 and administration of the project was given to the Manpower Services Commission. The purpose of the scheme was to prepare young people for the world of work and to develop skills that would help them to contribute to the life of their community, particularly where occupational skills are changing rapidly with new technology. In 1983 a pilot initiative involving 14 Local Education Authorities was set up. Schools were phased in and funds were not available to everybody at the same time. Our TVEI funding came to fruition in

1990, and we were able to install a new network of 22 Acorn A3000 computers to replace the ageing BBC Bs. The latter were offered to departments in the school who had to submit a request that detailed how many of the old computers they wanted and for what they were going to be used. These were then approved and discussed with department heads to ensure the computers would be put to good use in relevant areas of the curriculum. All interested parties were called to an open meeting, and the final distribution agreed upon so that everyone appreciated why some departments would receive more than others. The old computers were serviced, in many cases upgraded, and distributed to further boost individual department resources.

The TVEI funds gave us a breathing space to reorganise and redistribute hardware and aim for compatibility of hardware and software throughout the school.

7. Current Activities

7.1 Equipping for multimedia

The task now began of assessing our software and hardware needs for the new network room with its increased power. Initially only the essential software requested by departments was installed while we considered what our whole school software needs were. We eventually identified the word processing, graphics, computer-aided design, spreadsheet, statistics, graphing, database, desktop publishing, and multimedia packages that we would use in the school, and all departments were told of this decision. Site licenses were purchased for whole-school use of this software over a period of three years due to the expensive nature of a site license—anything from $120 to $700 (again US dollar equivalent). All the software packages are compatible with each other and in several cases the same software can be used on the old machines ensuring that maximum benefit can be made of this important resource throughout the school. Other software packages are now being purchased, and the cost of some site licenses is being shared between departments.

7.2 School-wide review of IT use

Careful mapping of the curriculum now followed, and all departments were asked the following questions as a way to review the key IT elements within the National Curriculum Document:

- What IT will be taught in Grades 7, 8, and 9?
- What hardware requirements are needed?
- What software requirements?
- When will the bursts of IT activity occur?
- What INSET programme is needed?
- How will INSET be achieved and can a suitable timetable be mapped out?
- Have sufficient departmental funds been set aside for IT components?
- Has the department identified a key member of staff to take responsibility for IT, i.e., an information provider and resource manager?
- Having mapped IT in the Lower School how will this progress into Grades 9, 10, and 11?
- What long-term plans for IT exist within your department ?

7.3 Development of a school IT grid

The answers to these questions enabled me to produce a grid of boxes with all the subjects taught in the school along the top and each of the grade groups down the side. (See Figure 1). Within each box corresponding to a particular grade and subject, the IT activity to be taught was entered. The whole staff can now see what the students' experiences are in each year and in other subjects, and we are able to ensure that there is no overlap in what is being taught. We can also ensure there are complementary activities and identify cross-curricular activities and what the likely needs are for pupils as they complete tasks. At the same time we can map out and ensure increased levels of skills and use of IT as the pupils get older and are in a better position to assess their levels of competence and document records of achievement.

Departments benefitted greatly from this exercise as they are now aware of their niche in the whole plan and are able to formulate, with some assistance, their own departmental policies. This is the exercise that is currently taking place and from this we will produce an elaborate whole-school policy for IT that can then be reviewed, evaluated, and modified as time goes by. Each department has a representative for IT, and they usually work on a one-to-one basis with myself or as a working group when I can call them all together for relevant training or discussion. This mechanism ensures the dissemination of information throughout the 89 members of staff and their departments.

7.4 Working with a "saturation level" of hardware

It is interesting to note that we have reached a saturation level where all the software we need to facilitate our curriculum needs is now available within the school, and we are now consolidating on its use within the curriculum. Naturally we keep an eye on new developments and experiment with new packages to keep up to date but our sole interest at the moment is to ensure

	IT TOOLS TO USE	DATABASES	CAD	VIDEOTEX	DTP	SATELLITE SYSTEMS	WORD PROCESSING	NUMERICAL FUNCTIONS	GRAPHIC FUNCTIONS	INTERACTIVE VIDEO	CONTROL TECHNOLOGY	PORTABLE COMPUTERS	SIMULATIONS
LEARNING MECHANISMS													
solo study													
practical													
group discussion													
project work													
fieldwork													
games/simulations													
PUPIL NEEDS													
subject knowledge													
numeric skills													
decision making													
communication													
graphic skills													
design													
data processing													
research													
SUBJECT AREAS													
Art													
Biology													
Business Studies													
Careers													
CDT													
Chemistry													
Computer Skills													
Drama													
Earth Science													
Economics													
English													
Geography													
History													
Home Economics													
Languages													
Maths													
Physical Education													
Physics													
Religious Studies													
Special Needs													

Figure 1

maximum use of the resources we have now established.

Peripherals are now increasingly important to us such as printers, scanners, and data loggers, and this has evolved as a need from the pupils who want to produce more and more elaborate output and hard copy of their coursework.

7.5 Pilot school for an evaluation of Design Technology as a new course in the National Curriculum

Another phase of enrichment came when the school's bid to act as a pilot for evaluation of Design Technology in the National Curriculum was accepted. We received a laser printer, colour printer, and four Acorn Archimedes computers for use in the classroom to develop materials.

The new national curriculum area "Technology" was introduced into schools for the first time in September 1990. During the preceding year Netherhall School was one of four schools in Cambridgeshire selected to pilot the Technology curriculum. The County Council supplied computer equipment to help with the project. The project team has consisted of teachers in the departments of Art, CDT, Home Economics, and Information Technology.

To carry out the project a group of 80 pupils was chosen who were at that time in the Second Year. The new Netherhall Youth Centre was opened in September 1989. This was selected as the context for the project. In each subject pupils have been designing and making items for use in the Youth Centre:

- Art designs for the decor of the Centre and murals for the walls;
- Home Economics researching and making suitable foods;
- Textiles making soft furnishings and toys for the creche;
- CDT making scoreboards for the Sports Hall, designer dustbins, toys.

In each of these subjects, pupils have made extensive use of Information Technology in their designs, analysing research data, and writing reports on their work.

As far as the teachers were concerned, the project lasted the whole of the school year:

- September to February—planning and inservice training
- March to May—classroom work
- June to July—evaluation and reporting.

The aims of the pilot evaluation project were:

1. To investigate the opportunities and problems in coordinating the work of the four departments to implement the National Curriculum programs of study.
2. To enable pupils to experience the full range of Design Technology activity as defined in the Statutory Orders.
3. To develop the use of Information Technology within the CDT, Home Economics, and Art departments.
4. To enable pupils to work in teams.

The Netherhall School site has recently had a new Youth Centre built following the sale of a piece of land. The new Youth Centre has provided an excellent theme for the work of all the departments in this project.

The focus of Art & Design was the internal environment of the Centre; in CDT it was the designing and making of artefacts for use in the Centre; in Home Economics there were two focuses—the planning and making of suitable foods and the designing and making of artefacts in textiles.

The staff of the Youth Centre were very happy to cooperate with the school in this project. They have taken on the role of the client, and hence it has been possible to introduce increased relevance and economic awareness.

The project has in total occupied a full academic year. This included three phases:

- Planning and INSET September to February 89-1990
- Pupils' work March to May 1990
- Evaluation and writing-up June to July 1990

The planning of the project took on several aspects:

1. Meetings of all departments to plan overall strategies, methods of working, coordination, etc.
2. Meetings of individual departments to develop schemes of work and lesson plans;
3. Considerable inservice training for all teachers in new technology.

The whole project, though demanding of time and effort, proved very rewarding for all staff involved. The opportunities of working with other departments and the experience of exchanging and sharing plans

within departments has generated some stimulating discussions which need to be further developed. Time to continue with preparation at this level, however, is unlikely to be available and difficult to manage with the existing locations of departments.

8. Department Policy and School Planning

8.1 School decision making with respect to budget

Another important development has occurred since 1990 in that schools are now responsible for their entire budgets. Whereas in the past the Local Authority has controlled funds centrally, funds have now been distributed to schools so that they can manage their own budgets. As long as there is a very careful and professional management regime, funds can be targeted in certain areas that were previously just not possible. In other words, the Headmaster is free to buy the services, contracts, furnishings, hardware, time, additional support staff, and so on that his school wishes, and to this end we have been able to employ an IT technician and increase the funds available for maintenance and progression of IT within the school. The IT technician for the last year has almost solely been concerned with helping to promote the use of IT within the classroom, notably developing database materials, collating software articles, cataloguing materials, providing one-to-one support for teachers during free study time, supporting in the classroom where teachers feel insecure with the operation of hardware or software, and helping with the day-to-day maintenance, cleaning, and moving of equipment to help resource departments with their needs. Naturally as we have increased the facilities for departments demand has grown, and we have seen a dramatic rise in numbers of teachers attending workshops and asking for curriculum support. This in turn leads to a greater demand for resources, which in turn leads to greater and greater funding needs.

8.2 New demands for integrated instructional resources

As a result we have been busy collating departmental IT packs, which are to be distributed to departments at a forthcoming training day. These packs contain software and hardware catalogues, database files of whole school resources such as hardware distribution, newspaper articles on IT for the last two years, desk top publishing files with outlines for records of achievement and headed notepaper for letters, and so forth. The training day will involve a representative from every department in the school, The IT Working Group, and this core of 14 staff will be given an update on curriculum developments, the school's IT curriculum map, IT departmental policy and the future techniques and methods of assessing IT in their subjects, and a plan for meeting inservice needs. They will be trained to take responsibility for IT in their subject areas and to pass this responsibility on to others in their department and so increase not only their own professional status but increase the awareness of everyone in their role in promoting IT within the curriculum.

9. Current state of affairs and philosophy

9.1 Resources

Since the summer of 1991, the school has been equipped with 130 computers, and 72% of the staff are confident and competent classroom users of information technology in the classroom. We hope to raise this to 85% by the summer of 1992.

9.2 Philosophy of funding

Basically the development of IT in a school is not cheap, and an input of large amounts of money cannot and must not be viewed as a one-off payment but as a loan from which a business can grow. If successful, the business will grow, and the staff and students will benefit by having greater access to more and more outlets and a greater choice of products to choose from and through which they can manipulate, design, and communicate their own ideas. Unfortunately in education we are not able to make profits from our products which in turn can be put back into the system to support the "Company." Our profits are the end result of what the students have achieved and produced, the skills they have learned, and how well we have prepared them for the technological world they are now facing.

Increased funding is needed whether it is from central government or from sponsorship by local companies involved with the school.

9.3 Importance of stepping stones

It is also difficult for schools to cope with sudden and dramatic influxes of hardware without well placed management strategies that address curriculum matters, staff inservice needs and time, funding, and a forward visionary policy to ensure that financial support and funding is not put to waste. Stepping stones are vital for the successful and continued use of IT within schools for both teachers and students. These stepping stones are the building blocks on which teachers gain confidence to be classroom facilitators of IT, and if all goes well, competent teachers of IT within their subject and across subjects. Obviously development rates vary and repetition of inservice is constantly needed as well as more advanced programs of training within the school. Dynamic inservice providers that command the respect of colleagues and students are essential, and they must be given time to work with individuals and support other colleagues within the classroom. They must be given time to develop materials and, depending on the size of the school, this is not a role for one person but a team supported by technical staff. If the management regime is right, IT will be successfully integrated within the school and blossom—with time.

In this section we offer a summary of the nine case studies from Section 2 and more generally reflect on technology-enriched school projects. The summary chapter focuses on similarities and differences in the TES initiatives themselves—in their goals, organization, activities, results, and in what the case study authors offer as recommendations for other TES projects and for other schools seeking an "enriched" use of technology. The section concludes with a short reflection chapter that addresses three major questions with respect to technology-enriched schools. As much as possible we have tried to objectively summarize the case studies, and to synthesize them in a way that reflects them most clearly. For this reason, we include a lengthy appendix in the first of the articles in this section that gives more background over why we have made the conclusions that we have. However, the opinions here are those of the editors, and may not be the same as those of the case study authors.

Summarizing the Case Studies of Technology-Enriched Schools

by Betty Collis and Gerrit Carleer

Introduction

In Section 2 of this book are reports about 19 different technology-enriched schools, discussed in nine different case studies. How can we summarize these studies? In Section 1, we noted the importance of trying to pull together the experiences of different technology-enriched schools in order to better learn what to expect in other situations where a school becomes technology-enriched with or without the framework of a special project. By asking each of the case study authors to develop his or her report around five standard headings, we hoped to help facilitate this comparing and summarizing process. In this chapter we will offer our own summary of the nine case studies. In particular, we compare and contrast the case studies around the following questions:

1. *How did the "technology-enriched school" projects get started?*
2. *How do the goals of the projects compare?*
3. *How are technology-enriched projects organized from a point of view of personnel and time?*
4. *How is technology being integrated into instruction in technology-enriched schools?*
5. *What about technology-enriched schools from the perspective of the classroom teacher? What are strategies for teacher involvement, motivation, support, and training?*
6. *What results are emerging from technology-enriched school situations?*
7. *What recommendations do persons involved in technology-enriched situations make to others moving into similar projects or situations?*

1. How did the "technology-enriched school" projects get started?

Is there a clear pattern in the case studies in Section 2 with respect to how their respective technology-enriched school projects got started? What are the characteristics of the schools involved in the projects? Who are the major partners in in the projects? In Appendix A we give a detailed summary of each of the nine case studies with respect to these questions; in the following paragraphs we give the major trends.[1]

1.1 Initiation of the projects

To start a project someone or some combination of partners has to take the initiative. There are different ways to group our case studies with regard to this point of initiative. We see one distinction relating to the origin of the TES activities: if it were within or outside the participating schools. A second distinction relates to the degree to which the TES activities can be seen as evolving from other computer-related activities and projects.

In six of the cases, the TES project was initiated outside the school. Schools competed to become involved, but the basic shape of the project was already established. In three cases, the schools were centrally involved in the instigation of the TES initiatives; as an extreme, the Netherhall School in the UK is a study of how one school can take its own initiatives or can move to capitalize on external initiatives that become available. However, it is clear from the cases that the initiative for a technology-enriched school project can come from a variety of levels and sources.

No school activities happen in isolation and certainly not TES projects. A major point of similarity in the cases is that all occurred in the context of already extensive experience with computer use in most of the schools involved (although "extensive" is a relative word). None of the projects is investigating if computers can or should be used in schools, but rather how to better use them and what happens when they are used more extensively than is currently normal for a system. (These background motivations also relate to the goals of the TES projects; we summarize these separately in the next section of this chapter.)

However, at least five of the cases can be seen as evolving fairly specifically out of prior regional-level and school-level projects and initiatives, while the other four begin more specifically as special projects (although two of these could also be seen as attempts by a state or region to consolidate its extensive past experience in a "demonstration-type" project).

[1] This will be our pattern in this chapter: we first synthesize the case studies in outline form (with these summaries in appendices at the end of this chapter) and then we do a further synthesis here. The appendices may be interesting to those who want to see the major aspects of the case studies organized around different topics. They also serve as a reliability check on us, so that readers can see the decision making we went through in selecting main points out of the cases.

1.2 What are the selection criteria for schools to participate in TES projects?

In some of the cases a school was selected as a project school because the school already had more experience with the use of computers than an average school. In some cases the school and its teachers had no special computer experience. Sometimes a key criterion for selection was the school leadership, for example, a combination of a highly talented principal and a knowledgeable and reliable teacher-technologist. Sometimes there was a demographic reason for the selection of a school. Sometimes the school involvement grew naturally out of previous contacts the school had had with the Ministry or district or researchers; other times the competition was "blinder" or based more on stated proposals submitted by the schools for a formal competition. The point of summary here is that the rationale for school involvement in the TES activities differs from case to case. Again, a detailed summary is given in Appendix A.

1.3 Partners in the projects

All the North American projects—except the Quinte Lighthouse School in Ontario—mention the participation of an industrial partner in the TES project. Netherhall School in the UK has also made occasional collaboration with business or industrial partners. The other European projects are funded by their government and/or Ministries of Education. The practice of sponsoring educational projects by industry is not as familiar in Europe as it is in North America; also, European projects tend to be more stimulated by researchers than are North American TES projects. Appendix A summarizes all the partnerships.

2. How do the goals of the TES activities compare?

It is difficult to compare the goals of the technology-enriched schools in Section 2. There are many reasons for this difficulty. Although the authors of the case studies were asked to explicitly state the goals of the projects in Section 2 of their articles, we found additional statements of goals in many other sections of the case studies. More problematic is the issue of implicit or broader goals underlying the TES activities. All of the case study authors might well agree, for example, that the eventual improvement of students' "ability to solve complex problems?" is a basic goal of their whole educational system, and thus is an obvious and implicit part of the context of technology-enriched schools. Because it is not stated explicitly as a goal of a TES project does not mean it is not important to the project. It is of course impossible to expect that TES projects will list all of these broader educational goals, or even that they can be listed.

Therefore, in this summary we will limit ourselves to what the authors actually stated as project goals in the second sections of their articles. These are given in Appendix B. Here we will discuss our main impressions of these stated goals. We give impressions relative to student-focused goals, teacher-focused goals, and school-restructuring goals. We contrast the goals with respect to what is expected of the various projects. Finally, we offer an observation on the measurability of the goals.

2.1 Student-focused goals

It is very interesting that relatively few of the stated goals of the TES activities directly mention students. None of them explicitly set as a target that students will perform better on traditional measures of school achievement. Only one gives detailed, measurable objectives with respect to student competencies with the use of computer-related technologies (for example, "By the end of Grade 8, all students will be able to demonstrate a high degree of skill in accessing and manipulating information stored in a computer database").

When students are directly mentioned as the focus of a goal, it is more often in terms of behaviors that are process- rather than product-oriented with high-level cognitive functioning stated or implied ("Students will become gatherers, analyzers, and managers of information...").

However, most of the times when students are mentioned, it is in terms of what the project will do for them or supply to them, rather than in terms of what the students might be expected to achieve because of what is supplied for them. This has important implications with respect to eventually "measuring the success" of the projects. Is a project successful if it has created a rich and stimulating learning environment, or must it demonstrate that there are also substantial changes in student learning?

2.2 Teacher-focused objectives

As a reflection of this tendency of the objectives to focus more on what the project will do than on what students will do, there are a number of objectives related to how teachers will integrate and use technology. These range from fairly specific ("Use technology in the classroom as a tool to enhance the Graded Course of Study in the areas of mathematics, science, language arts, social studies, and keyboarding"), to quite general ("Utilize the computer's potential for innovative teaching...").

2.3 School-restructuring goals

Some of the goals relate to overall change in the school atmosphere, change that might go as far as leading to a "restructured?" school. Examples of this include:

> "Change the general atmosphere in schools, making it more permissive, fully stimulative for pupils' creative capacities, by means of infor-

mation technologies?" and

"Create a 'supportive ecology' in which a 'future computer culture' can expand."

The latter is an example of a goal that goes outside the boundaries of the school. However, as a whole, the goals do not particularly suggest "restructured?"schools, although they do suggest "enriched," "expanded," "modernized," and "revitalized." However, is "restructuring" something more than this?[2]

2.4 Goals related to the tasks of the projects themselves

The projects can be compared on the degree to which they are charged with "demonstrating effective practice"compared to "observing what happens." At least three of the cases have the responsibility of "demonstrating"the "effective, efficient"use and implementation of technology. It is not clear how and to whom these "demonstrations"must be given, although the Monterey case is the most explicit. At the other end of the "proving and disseminating effectiveness" continuum we see the Dutch project, whose goals are stated only in terms of "investigating the impact..."of a technology-enriched environment.

2.5 Observations related to the goals

If we think forward to how the "success" of these technology-enriched school projects can be measured or estimated (see the "Reflections"chapter in Section 3), one strategy is naturally to relate the project's outcomes with its goals. This will be difficult for a number of the stated goals of these TES projects, because of the complex way in which these goals have been stated. Take, for example, the goal:

> "Make it possible for students to utilize skills and knowledge acquired from their education (content) combined with the tools now provided by technology to make independent, self-directed self-regulated decisions that will optimize their ability to solve complex problems both in and outside the classroom."

How can we measure the degree to which this goal has been met? Do we focus on the extent to which the TES project has helped "Make it possible..."? How do we measure the extent to which students make independent, self-directed decisions, particularly in the context of solving "complex problems...outside the classroom"? And what does it mean to "optimize a student's ability"? How can we measure this? [3]

We can make another general observation about the goals: If we look at the verbs in the stated goals, we see the following collection:

> ...Prepare a, demonstrate the, provide guidance to, disseminate the, make it possible for, design a...model for, create an, use, become, investigate the, change the, familiarize students with, integrate, create a, create an, utilize the, integrate, develop ...

Only one of these is the start of a goal statement that specifically relates to what *students* will do. The rest of the verbs lead into goal statements that describe what the adults in the project will do. This will have a major impact on deciding if the projects are "successful?"or not in meeting their goals. A major assumption in the projects is that the activities in the projects that the adults are "doing" (all the demonstrating, preparing, investigating, creating, preparing, etc.) will result in better student outcomes.

3. How are technology-enriched projects organized from a point of view of personnel and time?

3.1 Additional personnel

Making use of information technology and integrating computers in education is still a relatively new activity for schools and teachers. It is also an extra activity, to be handled while the most of the "old" activities still have to continue. In all of the case studies teachers are doing more than their regular tasks within their regular time.

But the amount of work to be done is enormous, and there are few proven strategies and models for mastering the tasks. So in all TES projects in the case studies, extra personnel or extra time for existing personnel are involved. We summarize in Appendix C the persons with formal time allotted to the TES projects. (Netherhall School, where the activities are largely evolutionary within the schools and more or less experienced with the school's own funds and personnel, will be excluded from the rest of our summary comments unless it is mentioned specifically.)

All the projects have made arrangements for extra personnel for coordination. Sometimes a distinction is made between the internal coordination in the school and "external"coordination between different schools and/or a school and external participants in the project. The latter happens when the project is not initiated by the

[2] In ISTE's *Vision: TEST Final Report* it is noted that "Discussion of restructuring is difficult because there is little agreement on the definition of the word" (p. 30, in: Braun, L. (1990). *Vision: TEST. Final Report*. Eugene, OR: ISTE.)

[3] (By the way, it is interesting to note a cultural assumption in this goal—that complex problems are best solved by independent, self-directed, self-guided decisions. In contrast, it is also increasingly felt that complex problems outside the classroom must be dealt with through cooperation in multidisciplinary group efforts. Thus "independent, self-directed, self-guided decisions" may not be the best approaches for solving complex problems in the 21st century workplace!)

school itself but by an external initiative. In all cases at least one person is responsibility for the internal coordination activities. Some of the projects have a highly structured organization, and the coordination activities are done by teams. We can appreciate that considerable time is invested in project meetings and internal communication when we look at the complicated project structures.

To be able to make use of computers and to integrate computers in the curriculum, teachers need time, training, and support. We will summarize in a later section of this chapter major trends with respect to teacher training and support. Here, we will note only that much of the project's budgets relate to personnel, and personnel for teacher support and training are a significant portion of the overall project cost. For example, at Mount Newton three teachers have released time "... to provide mentorships for colleagues, and to oversee the technical and instructional issues related to technology," and the school's computer aid "plays a key technical support role." At Monterey "assistance is provided by project personnel, consultants, and district mentor teachers"for teachers working on CIPs." In a number of the cases the lab manager in each school provides technical assistance. Sometimes project assistance comes from outside the school, from the computer company, or a research institute involved in the project.

Regardless of how projects are organized, participants agree that the support persons working on the projects are essential and kept very busy. We can conclude that inservice training cannot adequately solve implementation problems. Teachers need support onsite, especially on technical matters, to feel comfortable in using computers. It appears that even in technologically-enriched environments computers are still technically too complex for unproblematic, effective use by an average teacher.

3.2 Researchers

When researchers are involved in a TES school, their activities may range from prescriptive to descriptive. "Prescriptive"means that a researcher gives training or plays a leadership role in determining the activities at the schools. We see this in at least three of the case studies. In two other cases, researchers are involved both in describing what is going on in the school and also have an influence on some of the activities. This is the case, for example, at West High School where a researcher worked with teachers to integrate software developed by the researcher. In other cases the research is more descriptive or evaluative in function and does not directly influence the activities at the schools involved in the project. In at least one project, the Monterey project, an "independent research and evaluation coordinator" is concerned with measuring the success of the project. Thus, as a generalization, research is seen as valuable, but the projects vary a great deal in how much research informs their decision making or execution.

4. How is technology being integrated into instruction in technology-enriched schools?

In all of the cases we see computer-related technology being integrated into instruction in traditional subject matter areas. How can we compare and contrast the way this is happening? Approaches include looking at the software in use, the actual physical integration of technology and instruction, the choice of subject areas for technology integration, special instructional emphases within a project, or overall trends in instructional strategies involving technology.

4.1 Software trends

With respect to types of software in use, we definitely see applications and tool-type software in every project. Certainly word processing in support of writing appears in every school described in the cases. Desktop publishing software is important in about half of the described schools. Different types of databases appear in most of the projects, sometimes organized around hypertext software or on CD-ROM storage. In at least two schools telecommunications access to online databases is occurring. Spreadsheets are mentioned in three of the cases. "Integrated"software packages are standard in most of the cases. Curriculum-specific software such as drill and practice, tutorial, and simulations is mentioned in most of the cases, but usually given less emphasis than applications and tools. Programming languages are not often mentioned, although Logo and LEGO Logo are aspects of two of the cases.

Overall there is a distinction among the cases regarding software, but it is more of a continuum than a clear separation. The distinction relates to the use of software as tools, applicable to activities in many different subject areas, compared to the identification of useful instructional software relative to existing specific curricula. In the first of these, the end goal is, implicitly perhaps, that productivity and creativity tools are available to all, for self-directed use, not specific to a certain subject or teacher. At the other end of the continuum, the model is more that of the teacher finding content-specific software to specifically help students learn certain subject matter. The West High School case is an example of an emphasis on the tool-end of this continuum; the Dutch case of an emphasis on the "instructional"end (although each project clearly makes use of many different types of software). Each of the cases has some of each kind of software and software use within it.

4.2 How are computer hardware and software organized for access?

With respect to the physical integration of computer-related technology into the school setting, all of the cases have computers in laboratories, meaning in general that instruction must move out of the "base

classroom"and into a different room to make use of these exemplars of the technology. Most of the projects have more than one computer laboratory; most have dedicated technology also available in the libraries and for school administration, and many feature other workstations or smaller groupings of computers in addition to the laboratory computers. Many note individual computers available for the "traditional"classroom. Only one of the schools mentioned in the cases—one of the Israeli elementaries—appears to have specifically rejected the computer-room concept in order to maximize the dispersion of computers into classrooms.

Some of the cases specifically include a broad range of educational technologies, not only computers; the Monterey schools and Netherhall School are major examples. Multi-medias, particularly interactive video, are important in some of the cases and not present in others. There are no major trends about type of computer or associated equipment, as this relates very much to availability in the larger community.

4.3 Instructional applications of computers in the projects

We see many exciting ideas of instructional application of computer-related technologies in these case studies. Each of the cases gives examples; too many to summarize here. Some omissions however, are interesting to note. We see relatively little mention of MBLs—the so-called microcomputer-based laboratories—where special sensors and software serve to support and extend science instruction and experimental work. We see little mention of telecommunications activities for instruction. We see little mention of so-called "integrated learning systems," where students are individually tracked and managed through large and carefully organized curricula, usually basic mathematics or language. And, as mentioned before, we see little programming.

Another interesting distinction between the cases is the presence of "computer literacy"courses. In some schools we see informatics or computer-skills courses still in place; in others we see only a keyboarding unit; and in others we see the specific rejection of such "computer-as-an-object-of-study"courses.

Finally, we see little evidence of interdisciplinary instruction, particularly at the secondary level. There are a number of noteworthy innovative projects some of which involve interdisciplinary aspects, such as the cross-school project work at Black Middle School and of course, the impressive interdisciplinary community-related projects at West High School, but in general we do not see a "restructuring of education," at least with respect to the traditional pattern of subject-area organization, in most of these cases.

5. What are strategies for teacher training and support?

A major common theme in all of the cases is the importance of the teacher in the TES projects. In the West High School case study, as one example, we read that "The key to having a successful plan is to have teachers committed to the program and excited about the prospect of using new technology in their classrooms." Building this commitment and excitement occurs in a variety of ways in the cases. Appendix D contains a detailed summary of Section 3 of each of the case studies; in the following paragraphs we highlight impressions and trends.

5.1 "Traditional" inservice courses

There are, of course, traditional workshops and short courses, with many different structures, often available after school hours. Most often workshops occur in the school, under the leadership of the school computer coordinators or project specialists, such as in the Dutch, Monterey, and Mount Newton cases, or perhaps involving teachers from other schools, such as at Netherhall School. Some interesting variations on traditional workshops occur: In Quinte School, teachers invited software developers to conduct workshop sessions within the school so that the developers themselves could demonstrate their own software packages. In the Israeli schools, workshops were also offered to parents, retired senior citizens, and high school students for skills relating to the support of the teacher in the classroom or lab. In at least three of the cases researchers are called upon to design and deliver quality inservice.

5.2 Trends in inservice

A trend is clear in most of the case studies—inservice tends to begin with some relatively traditional sessions, but quickly evolves toward a more individualized approach. The Mount Newton case, for example, describes "mentorship" inservice, with personal follow-up of more traditional inservice and subsequent one-to-one assistance, and calls this choice of "an in-house model of mentorship inservice perhaps the single most important decision of the entire process." The Monterey approach, built around C.I.P.s (Classroom Intervention Plans) is focused on the needs of the individual teacher and thus follow-up support and assistance is individualized, tailored both to the ideas of the teacher's CIP and also to the teacher's psychological and social needs—"some one person to listen to concerns, fears,...the provision of moral support within the historical isolation of the classroom instruction during 'risky' instruction"...and is much helped by the SuperSub support.[4] Black Middle School also emphasizes individual assistance, and also includes the provision of a resource bank of individualized instructional modules for the teachers, available to them to work through at their own interest. Quinte School moved toward a goal

of individual assistance, focused on personalized ideas for lesson integration, and noted that "on-going support is critical." The administration at West High School is praised for providing flexible scheduling for the ACOT teachers, so that they can meet together with project support persons every afternoon.

It is clear in all this that on-site, personalized support focused on lesson integration is valued by most of the projects participants. It is also clear that this is expensive. Not only must an appropriate person be available on-site (and most of the projects have more than one person in this role), but released time and substitute support must also be organized. The SuperSub model is particularly interesting in this respect, and the Israeli plan to involve parents and members of the community for various types of teacher support is also very interesting. With so much individualization, the development of a school-wide overview, such as the curriculum map of IT at the school described in the Netherhall case, becomes increasingly important.

There are other strategies for teacher support. Many of the projects have arrangements for teachers to take computers home, or to buy computers at a subsidized rate. Most have organized regular meetings of teachers with each other and with project staff. Model or demonstration lessons are mentioned frequently.

However, the overall trend is toward individualization—one-to-one coaching, feedback, guidance, and support. Only one case talks about the desirability of moving beyond this to more independent teachers. It is clearly necessary to have support persons who can provide curriculum-related instructional ideas and mentoring. Sending teachers to an occasional workshop outside the school is practiced by no one. And finding a way to give the teacher time for this individual interaction is a necessary component. A critical question is: To what extent can this very expensive personal component be replicated in the non-TES school?

[4]The "SuperSub" idea in Monterey involves a corps of well-equipped and well-prepared substitutes who are readily available to take over class responsibilities for a teacher when the teacher requests individualized inservice help. moving beyond this to more independent teachers. It is clearly necessary to have support persons who can provide curriculum-related instructional ideas and mentoring. Sending teachers to an occasional workshop outside the school is practiced by no one. And finding a way to give the teacher time for this individual interaction is a necessary component. A critical question is: To what extent can this very expensive personal component be replicated in the non-TES school?

6. What results are emerging from technology-enriched situations?

It is extremely difficult to synthesize the "Results" of the case studies. One of the reasons relates to the distinction between "process" and "product" results. In a sense, everything that happens in the TES projects is a "result," and therefore the evolution of the activities over time, what teachers and students are doing and trying, and the growth of strategies for teacher support and inservice, are all "results" of the projects. Thus in many cases, what the case study authors describe as "What is Happening" in Section 4 of their articles could also be called project results (for example, students starting to use spreadsheets as a tool for problem solving in mathematics). Another difficulty is that "results" often relate to a process of change, in attitude, experience, work habits, and approaches to problem solving. To attempt to label the position of growth and change in areas such as these in terms of "results" implies that the process is finished, is measurable, and can be measured for comparative purposes with "preproject" status or with what would be expected to naturally occur over an extended period of time in the well-functioning school. None of these assumptions are manageable.

However, it is not unreasonable that we look for a summary of the "results" of these sort of TES-initiatives. There were goals specified for each project, many of which can be assessed at least in terms of progress. Decision makers in other schools would like to be able to better predict what to expect if and when they develop similar technology-enriched environments in their own schools. Those who have invested in technology-enriched projects, not only in money but in time and belief, have a natural desire to know if there are "results" from their efforts.

Thus we will try to summarize trends in the "results" of the case studies. We had asked the authors to specify and summarize the "results so far" in their projects in the fifth sections of their reports. Most commented to us on the difficulty of doing this, both because of the process-product distinction mentioned earlier, and the difficulty of talking about "results" when change and exploration and growth are slowly evolving and multifaceted, rather than measurable and well described. However, each author did supply a summary in Section 5 of his or her case study of what seemed to him or her to be "major results" to date. We have summarized these Section 5s in Appendix E, and here will give our overall impressions of the trends in what the authors call the "results to date."

We can note trends in results with regard to teacher change, student change, school-level change, and project insight and transfer.

6.1 Results with respect to teachers

All of the case studies note that at least some of their teachers are "making significant progress," showing willingness to innovate, reflect, and change their instructional strategies. Teachers generally are positive and are becoming gradually more accustomed to the computer as a tool. Teachers are using computers in an increasing variety of subject areas and in an increasing variety of ways.

However, not all teachers in TES project schools become enthusiastic and insightful computer users. And even for those who are enthusiastic, the case studies generally agree that on-going support and motivation are important to teachers' sustained involvement and growth. The case studies also agree that teachers must be committed, need time, and will benefit from access to computers outside of the classroom.

6.2 Results with respect to student change

All of the case studies note that students "take naturally" to computer use, are generally enthusiastic about computer use, and are moving into more and more independent uses of technology as a tool for other instructional tasks. There are also a number of reports of gains in various measurable student outcomes, although most of the cases note that much of what seem most significant about student growth with respect to technology use is not measured on current tests or by current procedures. What is noted about student gains is particularly important from the point of view of decision makers and thus will be resummarized (from Appendix E) here in highly compressed form:

Mount Newton
Method: Comments in students' "learning logs"
Result: Positive opinions of the students about learning more with technology

Monterey
Method: Large variety of measures, including teacher reactions, student output, traditional test batteries, and achievement measures (however, "most CIP-specific data are based on observation and perception"

Results:
- Increases on standardized tests and measures of writing proficiency
- "Moderate impact"on grades
- Reduction in writing errors
- Increased enthusiasm for writing
- Increased cooperative learning
- Increased spelling skills, increases in problem-solving ability
- Increased attention span

West High School
Method: Success of "real-world projects," scholarships and job offers to graduates, traditional tests, affective measures, and observations

Results:
- Variety of successful projects in response to real community needs and assignments
- College scholarships and offers of post-high school work as technology consultants
- Success relative to control groups in writing, mathematics, and science tests, but the students "have demonstrated much more knowledge and problem solving ability than standardized tests measure"

Dutch TES Project
Methods: Observations, researcher analysis
Results: Changing attitudes of students toward learning—"more problem-oriented, independent, goal-directed...show more initiative while solving problems, more often correct mistakes...work in a more concentrated and task-oriented manner"

School No. 56
Method: Researcher observations and analysis
Results: "Pupils involve themselves enthusiastically in all kinds of computer activities and...have good results?" A deeper motivation for learning; more spontaneous contacts among students for discussions and exchange of programs

Comptown
Methods: A large variety of formal observations, interviews, researcher analyses
Results: Compared to control students, significant gains in multiple-inference problems, formulation and testing of hypotheses, data organization and identification of meaningful variables

F. M. Black
Method: Observations, achievement measures
Results: Increase in skills particularly in language arts and math, ability to develop their own solutions to problems, scores on statewide proficiency test "improved significantly" increase in morale and motivation for learning

Quinte Lighthouse School
Method: Observations
Result: Students view computers as a tool and use the tools regularly and effectively. Students are enthusiastic.

Netherhall School
Method: Ongoing assessment of student achievement and behaviors
Results: Students make effective use of technology as a tool throughout the school

From these brief summaries, we see very encouraging results with respect to the students in the TES projects in the case studies. The dramatic and undeniably valuable results at West High School (job offers, college support, strong community recognition) are particularly impressive. The shift among students in all the cases toward more and more appropriate use of technology as instructional and productivity tools is undoubtably an important result. The consistent comment about student enthusiasm and motivation is also important. Changes in students' approach to independent problem solving, to group cooperation, to new approaches to work and learning are powerful comments.

And there are even improvements to be seen on traditional measures such as standardized tests and report card grades. The fact that all the cases cite "important results" regarding student performance that are not usually directly measured on fact-oriented standardized tests or reflected on report card marks reinforces that often-expressed need for some reliable and accepted strategy to measure and give credit for the wider range of student outcomes and growth in technology-enriched environments. Perhaps the TES projects could add this to their lists of project goals?

6.3 Results with respect to school-level changes

Most of the cases indicate positive changes in "school climate" or describe important changes in the "school ecology." In at least five of the cases, this overall improvement in school climate is among the dominant results of the project, at least as described in Section 5 of the case studies.

6.4 Results with respect to project-level insights and transfer

All of the cases discuss the insights they have gained from their experiences with technology-enriched schools as a valuable result. Since these insights are frequently discussed in the context of recommendations for other schools and projects, we will comment on them in the following section of this summary chapter (Section 7: Summary of recommendations). However, it is noteworthy that a number of projects are already transferring their instructional and organizational strategies to other schools in a variety of ways. We see specific examples of this in five of the cases.

6.5 Overall comment about "results"

In general, with respect to "results," we might say that what is occurring in the technology-enriched schools of our case studies is that exciting learning environments are being established and are evolving in ways that are in some aspects similar and in others different, reflecting their different cultural contexts. Students are benefiting; teachers are being challenged and stimulated; indeed, "good things are happening." However, describing and documenting those "good things" in a comprehensive way is extremely difficult.

7. What recommendations do persons involved in technology-enriched situations make to others moving into similar projects or situations?

From the information the authors of the cases give and the way they describe the activities in their respective schools, readers must come to their own conclusions as to how to transfer the experiences to their situation. The authors were, however, asked to make recommendations both to other "technology-enriched school projects" and to schools in general as they naturally move into more technology-enriched environments. We summarize these here.

7.1 Teacher-focused recommendations

The strongest recommendations made by the majority of the authors relate to the importance of the involvement of the teachers. For example, "Time spent with staff is the critical necessary factor in developing effective instructional uses of computers in our new school planning" and "Put people first, especially teachers...."

A strong rationale for giving priority to the teachers is: "Don't feel guilty for investing resources for staff development at the apparent expense of students (such as allocating computers to staff). An investment in a teacher will pay off for hundreds of students in years to come." And, "the participation of teachers was chief determinant of the success or failure of the project." Teacher inservice and on-going support are stressed again and again as critical.

It is not only during the project that the teachers play a crucial role as executors of the project's plans and ideas. They also play key roles by setting up a project. For example, "It is also necessary that the teachers be involved and committed in principle before a major change is introduced if a positive and cooperative environment is to be maintained." Many recommendations are made relating to on-going, meaningful teacher involvement in decision making and planning. As one author says, "must emphasize here again the importance of thorough staff involvement in planning and design."

At the start of a project most of the teachers are not familiar with the instructional potential of computer-related technology, so they have to learn many things as well as develop many ideas. This takes time. Thus most of the authors make recommendations about making arrangements so that teachers have some free time and space for exploration of their new tasks. For example, "Provide leaders/mentors with planning and support time, and provide teachers with released time for in-service and follow-up." Also, the importance of providing for individualized support and models of instructional practice appears in many of the recommendations.

7.2 Recommendations about hardware and software

In contrast to the very detailed recommendations about teacher support and involvement, few explicit recommendations are made about hardware, computer configurations, or software characteristics. Aside from comments such as "...adequacy of resources are essential factors in effective uses of technology," we more often see recommendations emphasizing a deemphasis on technology: "Too often we see schools of the future designed around equipment and facilities, without placing staff and curriculum development front and centre in planning." Curriculum integration is also emphasized: "If the hardware is put into the school without curriculum support materials then its success is going to diminish after the initial excitement... ."

7.3 Recommendations about constraints

Finally, a number of the projects make recommendations that relate to being more realistic about the constraints of a project, especially during its initial planning and goal setting. Even in TES projects with plenty of facilities, not all the desired instructional ideas can be realized. Choices have to be made.

As an example, "Monterey has 'modulated?' its technology integration by utilizing the CIP planning process." This strategy is seen as useful for schools with no special funding "because adoption/adaptation can be undertaken in phases or in modules, depending upon the priorities or mission of a given institution." The Dutch project recommends a gradual broadening of project ambitions. Schools just beginning to add technology into their curriculum can "begin with Writing Centers that can be used by the entire school. Practically every subject involves some writing experience for students." In looking back, the F.M. Black School authors conclude that it was too optimistic to try to integrate computers into every branch of the curriculum. The new approach at Black can also be seen as a recommendation for other schools: "Today, instead of totally restructuring the delivery of instruction, the school seeks to work the technology into its current instructional organization causing change to become an evolution rather than a revolution."

7.4. Summary of the recommendations (and of this Summary Chapter)

Summarizing the explicit and implicit recommendations in the case studies, we come to the not-surprising conclusion that the success of using computers in education is dependent on people, not on technology-enriched environments. The effective integration of technology into schools is more a problem of Human Resource Management than it is of technology or even of financial or project management. Providing an environment in which ideas and human commitment can be stimulated and supported is the basic characteristic of effective schools, and also therefore of technology-enriched school environments.

Reflections on Technology-Enriched Schools

by Betty Collis and Gerrit Carleer

1. Introduction

This book had two primary functions. One was to contribute to the need for better information transfer about technology-enriched projects and their experiences. We believe that the nine case studies make this contribution well.

The second function of the book was to try to synthesize the experiences from a number of technology-enriched schools. One reason for this is to more efficiently provide recommendations and insights to others involved in technology-enriched school projects, or to others considering embarking on such projects. We hope the summary of recommendations from the case studies, which appears in the previous chapter, is helpful in this respect; the case studies themselves offer much broader and more valuable insights and recommendations.

A second reason for this book is that more and more schools, in their "ordinary" settings, are becoming technology-enriched, (certainly the Netherhall case study from the UK is a strong example of this), and thus can also benefit from the more formal TES projects. We believe the case studies offer insights of value to any school increasing its use of technology.

But synthesis should also stimulate reflection. In this final chapter, we would like to offer our reflections on a few key aspects of technology-enriched schools suggested by the case studies. One aspects relates to different ways of defining the "success" of technology-enriched school projects, a second relates to realistic expectations with respect to technology in schools, and the third to a methodology for doing research about technology-enriched projects and environments. Finally, we conclude by reflecting on the importance of disseminating our experiences to others.

2. Defining the "Success" of Technology-Enriched School Projects

Are these projects successful? Of course! There are many impressive results described, relating to student behaviors, teacher change, and changes in school and practice. Descriptions of student activities offer some very impressive ideas. The projects have stimulated and supported their teachers and contributed many insights to other projects. But if we think more generally about the meaning of "success" in TES projects, we could consider at least three general perspectives. Each perspective offers challenges to those involved in TES settings.

2.1 Success as a comparison of results with goals

One reasonable perspective for thinking about the success of a project is to compare the current status and output of a project with its planning and goals. This approach, however, doesn't work very well in practice, as goals are often stated too broadly or in too complex a manner to measure in terms of output, or because the outcome of goals will only be reasonably seen in the future, or relate to higher level change that we in education in general don't know how to measure well. So in terms of meeting their stated goals, we may have some difficulty in saying to what extent the TES projects in our case studies are "successes," although the projects are certainly moving in directions consistent with their goals.

One recommendation, therefore, might be for TES projects, or technology-using schools in general, to periodically reflect on their own goals, in order to revise or sharpen them based on their evolving experiences. This could be very helpful to other schools as well.

A different and more measurable way to define "success" is through use/activity indicators. We could say, for example, "Are the resources being used? By how many people? Are a variety of activities happening in the project? Are people doing new things?" But we must be careful. We cannot assume that use or activity or newness in themselves have long-range educational value based on what the community expects from its schools. We must show the connection between computer use and computer-related activity and, eventually, better performing/thinking/producing students for society to finally judge our TES efforts a success.

2.2 Success as a function of enthusiasm

A second reasonable perspective with respect to success is peoples' enthusiasm about the project. Certainly in our case studies, and in so many other technology-using schools we know, people are enthusiastic. Students clearly like the technology; teachers who make it through certain levels of difficulty can also become very enthusiastic. The technology-enriched schools described in the case studies seem like happy places.

As educators we KNOW this is good, just as we know the opposite—an unhappy school is not good. But we have a job to do here. We must find a way to convince skeptics that stimulating enthusiasm is an important goal in itself for schools, that happy and enthusiastic students are also learning better or more or faster or more deeply. Our case studies give a number of useful examples of "achievement" results of this sort, but most of the studies also indicate that measuring "what really is happening" is still difficult to do. As a result, many of the results we value the most are the most difficult to communicate convincingly to the "outside world"—or to the teacher in the next room who has no interest in tapping the potential of even the available technology in the school. We still have a way to go, apparently, in convincing many

teachers and administrators that the enthusiasm and "good things" we believe are occurring with computer use are real enough or important enough for them to try themselves.

2.3 Success and "cost-effectiveness"

Perhaps the above concern about demonstrating the effects of computer use in schools through indicators that will convince non-technology-using teachers or skeptical administrators seems not so relevant given the overwhelmingly positive impression communicated by our case studies. But the concern is valid because of another reasonable perspective which is very difficult to deal with respect to appraising the success of TES projects. This is the perspective of cost-compared-to-benefit, or "cost-effectiveness."

We are thinking of the "cost /benefit" ratio in a very broad way. Given the costs of these initiatives—direct and indirect costs in effort, time, money, reorganization—are the results "worth it"? If we had spent the same (or less) time, money, effort, on some other activity, would the gain be greater?

This of course relates to a school's goals and the priority those goals have in the overall spectrum of the needs and goals of education for a school or region. Those of us who are aware of the potential benefits to students and teachers of effective use of computer-related tools believe that the benefits of TES projects and environments are worth their costs (in effort, money, time, and organizational challenge). However, we must be sensitive to the need to convince educational decision makers and the public of this cost-compared-to-benefit issue; it is the decision makers and the public, after all, who make the final decisions about what will give the best overall benefit in schools for a given amount of educational dollars and effort.

In this context, to what extent will the public and educational decision makers think the results of the TES initiatives balance or outweigh their costs? Have we convinced them that we should continue to spend effort/money/time/and so on, on technology-enriched schools or do some of them think that it might be better to make these effort/money/time/and so on, investments on something else?

The TES projects, because of their visibility and scope, will have a significant influence on the public's opinion about these questions. The extent to which they can disseminate their successes is thus very important.

3. *Finding Realistic Expectations with* Respect to Technology in Schools

A second point of reflection with respect to TES projects and technology-enriched schools more generally relates to our vision of what is reasonable to expect from such environments. From these projects, and from our experience more generally, we know that effective technology use in schools is apparently still difficult to implement. Baseline conditions include adequate hardware and software access; adequate preparation time for teachers; adequate inservice and on going, individualized in-school support; supportive and effective principals, computer coordinators, and other support persons; willingness to change one's routine, to be flexible, to deal with uncertainty, extra work sometimes and extra organizational efforts.

The TES projects have tried to meet these baseline conditions as effectively as possible, with extra support, money, time, and resources not directly available in "ordinary" schools. (Although the Netherhall School example shows that an "ordinary" school can meet and far exceed these baseline conditions.) But when and how will we adequately meet these baseline conditions in a critical mass of ordinary schools, enough to allow technology to make a difference in the overall educational system?

Given their resources and careful planning, the TES projects can make a real contribution here, through strategies such as dissemination of some of their successful lesson ideas and providing models of classroom management for colleagues at schools not able to have the extra support personnel found in the TES projects. Dissemination is very important, and we see much potential for this in the experiences in the case studies.

But in general, what should our expectations be for technology use in "ordinary" schools? What are the dangers of expecting too much or too little? These are difficult questions.

4. Reflections on a Methodology for Research about Technology-Enriched Projects and Environments.

Finally, it is no new news that doing research about complex systems such as technology-enriched schools is also very complex. In this book we have tried to anticipate many of the criticisms of such research[1]—we asked thoughtful educators who are well-informed about technology-enriched school projects over a long period of time, in a systematic way to supply detailed analyses of their projects. Anticipating the problems of synthesizing multiple case studies, we worked with the authors on getting comparable information.

We tried to find a balance between systematic collection of information and freedom for the authors to communicate the unique balance of factors in each of their settings. But finding this balance was difficult. The problem was how to stimulate systematic case studies with a shared frame of reference (so that there would be adequate information for comparison and synthesis) without pressing the authors into a framework where they were not able to tell their own story, to report the aspects of their schools they most wanted to tell. Perhaps the Netherhall School article shows the advantage more freedom could have given to the authors. Also, we limited the authors not only in the frameworks of their reports but also in the quantity of what they could say. Thus in this way, too, we undoubtedly have constrained much of what the authors could have shared with the readers about their projects.

However, the individual styles and perspectives of the authors and their projects still do come through. The case study authors have done an excellent job in summarizing their complex projects and in providing both descriptive and reflective comments within our requested framework.

We still see the multiple case study method and the importance of knowing as much about the context of a technology-involved project as possible as valuable methods for research about technology-enriched schools. However, we recognize the difficulties and limitations of trying to apply this methodology well.

[1] We originally planned to write a careful analysis of difficulties in conducting research about the effect of technology in education and about promising methodologies for this analysis. We decided, however, to communicate through our approach itself—the version of a multiple case study that we have used for this book—rather than through a description of the theoretical rationale for the approach. We, and the readers, must of course reflect on how useful our methodology has been.

5. Finally, Dissemination

Our final reflection also relates to methodology but also to dissemination. How can we, all of us involved with technology-enriched learning settings, better synthesize our experiences? What and how can we learn from one another? What aspects of another's experience relate to what we can apply to our own situations? How can we, working together, as well as in our unique settings, improve the potential benefits of technology-enriched schools for our students?

We hope this book makes a contribution.
Enschede, October 1991

Appendix A

Summary of the initial Conditions of the TES Projects in the Case Studies

Mount Newton Middle School

a. Major background characteristics
- 1989 and later: planning a "technology-enriched environment" (a new school)
- the belief that the success of the new-school planning process is rooted in the staff development program, whose success is rooted in the roles of the inservice leaders and participants

b. Motivation for the project (before the start)
- preparation and planning of a new school

c. Initiation of the project
- the school district and the school
- previous experience: 1987 and 1988: two years of exploration, an attempt to help define the role of new technologies in classrooms

d. Key persons
Partners:
- State; Ministry of Education
- State-wide computer education institute (Education Technology Centre)
- Information technology industry (Apple Canada)
- Faculty of Education, University of Victoria

e. How the schools get involved
- own initiative, school and district

Monterey Model Technology Schools

a. Major background characteristics
- attention to cost-effectiveness
- six sites statewide (districts); each with two to four schools (K-12)

b. Motivation for the project (before the start)
- endeavors to demonstrate the effective use of technology in instructional delivery and enhancement, as well as in school management
- lessons learned and strategies developed must be useful to the broad range of Californian schools and students

c. Initiation of the project
- State

d. Key persons
- State Department of Education and State legislature
- educational community
- research and teacher-training institutions
- information technology industry

e. How the schools got involved
- a competitive grant process

West High School

a. Major background characteristics
- one high school, Grades 9-12 (only secondary school of six ACOT projects)

b. Motivation for the project (before the start)
- technology (computer and other high-tech equipment) should be integrated naturally into the curriculum of the Columbus Public Schools" Graded Course of Study

c. Initiation of the project
- information technology industry: Apple

d. Key persons
- Apple
- Columbus Public Schools
- Universities (Ohio State University and UCLA)

e. How the schools got involved
- competitive grant process
- previous experience of the district: Summer Tech

Dutch Technology-Enriched Schools

a. Major background characteristics
- Two sites, three schools; Grades 7-12
- initiated as a research project
- funding of the schools: PRINT (national management group for technology-related projects in schools)
- funding of research: National Educational Research Institute
- should include school-initiated and school-based inservice training

b. *Motivation for the project (before the start)*
- to investigate a broad-scale introduction of computers

c. *Initiation of the project*
- State (national level): Ministry of Education

d. *Key persons*
- Ministry of Education; PRINT
- Universities; Twente, Utrecht, and Amsterdam (research)
- (no industrial partner)

e. *How the schools got involved*
- competitive process, but based on previous experience with the researchers

School No. 56

a. *Major background characteristics*
- one school, Grades 1-12

b. *Motivation for the project (before the start)*
- research

c. *Initiation of the project*
- Ministry of Education
- Research Institute for Computers

d. *Key persons*
- Ministry of Education
- Research Institute for Computers researchers
- National Institute for Educational Sciences

e. *How the schools got involved*
- the school received computers from the Ministry, and a few teachers asked researchers for help

Comptown

a. *Major background characteristics*
- ecological conceptualization
- the nesting system
- scope of the experiment: the entire city
- six elementary schools

b. *Motivation for the project (before the start)*
- theory driven (researchers)

c. *Initiation of the project*
- researchers

d. *Key persons*
- Researchers
- Ministry of Education and Culture

e. *How the schools got involved*
- community and local leadership agreed to project

F.M. Black Middle School

a. *Major background characteristics*
- one middle school, Grades 6-8

b. *Motivation for the project (before the start)*
- demonstrate how microcomputers and related technology could make the process of instruction more efficient and effective and also to observe the effects of a computer-saturated environment.

c. *Initiation of the project*
- by Houston Independent School District

d. *Key persons*
- Department of Technology of the District
- Apple
- Union Texas Petroleum
- Compaq Computer Foundation
- (no university or research institute)

e. *How the schools got involved*
- competitive grant process: proposal followed by site visit from the District

Quinte Secondary School

a. *Major background characteristics*
- one secondary (high) school
- focus on all curriculum areas

b. *Motivation for the project (before the start)*
- The Ministry would like to demonstrate the effectiveness of the computer as an instructional tool (The public was demanding accountability!)

c. *Initiation of the project*
- Ontario Ministry of Education

d. *Key persons*
- Ministry of Education
- The Hastings County Board of Education
- (no research institutes or universities)

e. *How the schools got involved*
- competitive grant process

Netherhall School

(Note: Netherhall is not a school with a TES project, but a school which through a variety of initiatives has made itself a TES)

a. *Major background characteristics*
   - use of computers since the 1970s
   - one comprehensive school, Grades 6-12

b. *Motivation for the projects (before the start of the computer-use process)*
   - make use of external opportunities and funds

c. *Initiation of the projects*
   - Initially, Government (MEP-1981: development of software within schools)
   - Department of Trade and Industry (IVIS-1986: Interactive Video in Schools)
   - Government (National Curriculum Technology-1990)

d. *Key persons*
   - MEP (19811986)
   - the school

e. *How the schools got involved*
   - competitive grant process for some of the external projects

For each of the cases, the following format is followed:

Appendix B

Summary of Personnel Formally Involved in TES Projects, TES Case Studies

For each of the cases, the following format is followed:
Key persons:

a. Extra personnel involvement
   Name/function:
   - task, responsibility, contribution
   - functioning external/internal to the school(s);
   - new/already present (old);
   - continual/only some phases of the project

b. Other personnel support
   Name/function:
   - importance/contribution

Mount Newton

a. extra

three teachers
- in-service, mentorship, overview of technical issues
- intern; old
- 0.67 release time; continual

project leader
- school technology program design, staff development, new school technology design and networking, liaison with the participants
- extern;
- old
- half-time; continual

school's computer aide
- facilitates computer use, technical support
- intern; old; continual

b. support

principal
- educational leader

teaching staff
- must embrace new directions openly

district administration
- key facilitators
- school architect

Monterey

a. extra

project director
- external; new
- full time; continual

curriculum coordinator
- internal; new
- Year 1 and 2, full-time; Year 3, part-time

training coordinator
external; new
start: part-time; after six months: full-time
classified instructional aid
- an aid at one elementary school
- external; new
- full-time

b. other
- research team

West High

a. extra
- Site coordinator
- internal; old

district coordinator
- external; old

supervisor
- external; old

art support
- external; old

music support
- external; old

ACOT staff
- training and consultancy
- external

b. support
- research team
- Columbus Public Schools administrators
- flexibility in teachers' schedules
- principal of West High

Dutch TES Project

a. extra

consultants
- contacts between the participants; information dissemination
- external; new
- part-time; continual

coordinator
- coordination of all computer activities
- internal; old
- part-time

system manager
- functioning of computers and networks
- internal; old
- part-time

lab manager
- technical assistance
- internal; new
- full-time

coordination committee
- computer policy issues
- internal; old
- part-time

research staff
- introduction of courseware and assistance by inservice
- external; new
- part-time

b. other

School No. 56

a. extra

specialist from Research Institute for Computers
- technical and educational assistance; inservice
- external; new
- part-time

b. other

Comptown

a. extra

Five teams:
- Project's Management Team
- Center for Curriculum Development
- Evaluation Team
- Training Team
- Local Support Team

b. other
- Ministry's Steering Committee
- Municipal Steering Committee

F.M. Black Middle School

a. extra

project coordinator
- daily activities and project's progress
- external; new
- full-time

Instructional Development Group of the District
-
- external; new
- part-time

Software specialists of the District
-
- external; new
- part-time

Teacher Technologist
- support of teaching staff
- internal; new
- full-time

b. other

principal

Quinte Secondary School

a. extra
Board computer consultant
liaison school—Board/Ministry; inservice
- external; new
- full-time

computer site administrator
- inservicing teachers and students
- internal; old
- full-time

technical assistant
- internal; new
- full-time

b. other

Netherhall School

a. extra
four teachers
- to design software packages
- internal; old
- half day a week; 1981-1986

b. other
headmaster and senior management team
- forward vision

Appendix C

Summary of Goals, as Stated in Section 2 of TES Case Studies

Mt. Newton:

"Prepare a 'technology-enriched environment' that allows for thorough and appropriate uses of computers and related technologies for learning and teaching, as well as administration"

(Also, five explicit Planning Goals and 26 Implementation goals, 13 of which relate to what will be provided in the school to" prepare the technology-enriched" environment, five of which relate to expectations of student progress (#4, 5, 6, 9, 14), three relate to changes in schools organization (#11, 25, 26), and two relate to teacher support (#20, 21).)

Monterey MTS

Three goals of the overall MTS Project:

"Demonstrate the effective use of technology in instructional delivery and enhancement, as well as school management"

"Provide policy guidance on the best and most cost-effective strategies for using technology to meet [the state's] educational goals," and

"Disseminate the information necessary for the successful adoption/adaptation of promising practices in similar schools across the state" (p. 1)

Also, specific goals of the Monterey MTS Project:

"Make it possible for students to utilize skills and knowledge acquired from their education (content) combined with the tools now provided by technology to make independent, self-directed, self-regulated decisions that will optimize their ability to solve complex problems both in and outside the classroom," and

"Design a site or teacher-based planning and decision-making model" (pp. 7-8)

West High School

(From ACOT philosophy):

"Create a computer-saturated environment that encourages students' initiative, independence, and originality"

"Use technology in the classroom "as a tool to enhance the Graded Course of Study in the areas of mathematics, science, language arts, social studies, and keyboarding,"

"Students will become gatherers, analyzers, and managers of information..."

"the ACOT community of learners will not only support each other in learning, but will also seek to involve the staff and students at West High School, as well as the community at large" (p. 3).

Dutch Technology-Enriched Schools

"Investigate the impact of a 'technology-enriched school' environment on the school as a whole" (administration, 'climate,' curricula, roles and opinions of teachers, and the teaching-learning process) (p. 2).

School #56

"Change the general atmosphere in schools, making it more permissive, fully stimulative for pupils' creative capacities, by means of information technologies" (p. 3).

"Familiarize children with computers...as an element of their own culture", and

"Integrate computer use in schools" (p. 4).

Comptown

"Create a computer culture in schools,"

"Create a 'supportive ecology' in which a 'future computer culture' can expand," and

"Utilize the computer's potential for innovative teaching and learning, both in and outside the school" (p. 3).

(Also, see seven "Project Implementation Objectives," pp. 3-4).

F. W. Black Middle School

"Demonstrate how microcomputers and related technology could make the process of instruction more efficient and effective, and also to observe the effects of a computer-saturated school environment" (p. 1).

"Integrate computers into every branch of the curriculum" (p. 3).

Quinte

"Demonstrate the successful implementation of [Ontario-supported] computers and [Ontario] educational software" (p. 3).

"Demonstrate the effectiveness of the computer as an instructional tool" (p. 4).

Netherhall School

"Develop good classroom use of hardware and for integrating computer applications throughout the curriculum" (p. 1).

Appendix D

Teacher Inservice and Support: Highpoints from Section 3 of the Case Studies

Mount Newton:

(Teachers worked together to develop a school Technology Program document as an extension of the Educational Program for the school)

Jan 1989—released time for teachers, including significant released time for three in-service leaders on staff.

"Choosing an in-house model of "mentorship in-service was perhaps the single most important decision of the entire process" (p. 16).

Worked with university research partners to build-in key components of effective in-service; also use ACOT-defined levels of personal growth of teachers (entry, adoption, adaptation, appropriation, innovation).

Under leadership of on-staff mentors, staff development program: (a) familiarity / personal productivity, (b) classroom applications; (c) curricular integration.

1989-1990: full or half-day workshops for six to ten teachers, usually for (a) above; each followed by individual follow-up by the lead teacher with teachers on their own time; then (b) on classroom use of the application.

Interests of teachers are the driving force, but "this is not an inexpensive model."

Moving toward "peer mentorships" instead of inservice, with staff leaders providing one-on-one assistance in classroom and curricular integrations (with released time).

Teachers are encouraged to visit other classrooms to observe how others are using computer technologies.

Teachers take computers home.

People invited in to give model lessons.

Six teachers involved in collaborative action research with the university.

Summary: Key idea: one-to-one follow up by lead teacher after productivity workshop; then classroom application; moving to one-to-one mentorship; university relationship.

Monterey

Rationale is to gradually train and support in-house teachers as trainers, so that "assistance, support, and coaching would always be just a room or hallway away."

Staff develop C.I.P. (Classroom Intervention Plans) "around their own ideas, ideas which address student needs"; CIPs also have individualized staff development plan for needs of teachers implementing the specific CIP.

Inservice: trend is away from technology to curriculum applications and instructional strategies focus.

Follow-up support and assistance needed—"some 'one' person to listen to concerns, fears, ...the provision of moral support within the historical isolation of classroom instruction during 'risky' instruction is a high value item among MMTS participants."

- "SuperSub Service"—subs with mobile workstations, technology-based lessons aligned with curriculum; "allows teachers to sign up for customized assistance on a voluntary basis as they feel the need." This provides for weekly release time (45 minutes to an hour) for individualized instruction.
- More requests for demonstration teaching and coaching sessions

Summary: SuperSub allows individualized support for Classroom Intervention Plans.

West High School

"The key to having a successful plan is to have teachers committed to the program and excited about the prospect of using new technology in their classrooms."

- Flexibility in schedules allows team planning periods every afternoon.
- Summer Institute.
- Art support by a district media specialist and music support.

Summary: Released time for meeting and planning every day.

Dutch Technology Enriched Schools Project

- Regular meetings for released-time teachers.
- Two in-school coordinators and a system manager support the teachers in the school.
- Development team, including a researcher, works with teachers for preparation of lessons, observation, and evaluation of lessons.
- Inservice consists of classes, demonstrations, and individualized support. Most courses are internally organized by the school computer coordinator.
- Teachers have opportunity to buy a subsidized computer (PC-Prive project).

Summary: Emphasis on sharing of experiences within the department.

School #56

- Workshops conducted by researchers from Institute.

Summary: Voluntary participation; mostly young teachers.

Comptown

- Teachers acquired "computer skills and CBI proficiency and perception"; also skills in the design of new learning materials.
- Most teachers completed a CBT training program, which met once a week and was not paid for.
- "Steady school based guidance" provided by projects' "curriculum development centre."
- Training also given to parents, retired senior citizens, and high school students for support in the lab and outside the school.

Summary: Emphasis on change in teaching methods.

Black Middle School

- Teacher Technologist in the school with extensive training, functions as "technology catalyst and computer literacy teacher" (p. 18).
- Coordinators' duty is to communicate the concerns and successes of the teachers to the principal and ACOT personnel.
- Training classroom established.
- Variety of models for inservice, including before and after school, on Saturdays, during the teacher's planning period when the teacher can be offered extra help.
- Staff newsletter.
- Individual assistance from the trainer or project coordinator or another teacher during the teacher's planning period; also individualized instructional models, available in the library, with individualized instructional modules (sometimes with videos).
- Computer hardware and software issued to teachers who gained proficiency in computer use.
- Substitutes not available.
- Peer tutoring.

Summary: Individualized modules support flexible inservice.

Quinte Lighthouse School

"The key feature appeared to be teacher readiness."

- First, awareness workshops; then teachers invited the developers of software to the school to run workshops about their packages.

- Then more workshops, in small groups of five and ten; "It is very important that teachers receive rather prolonged support in labs with their classes."

  "Our goal was to provide as much support (hand holding in some cases as necessary) and then gradually begin to pull back" (i.e., Coordinator in computer room replaced by network technician).

- Then, inservice on more individual basis, with coordinator working individually on ideas for lesson integration. *"Ongoing support was critical in reassuring the teachers that they were not going to be left in the lab alone."*

Summary: Gradual weaning from support.

Netherhall School

- Early on, four teachers were released a half-day per week to design software packages, and pupils were used to program the packages.

- Specific teacher support materials developed.

- Then, workshops extended to subject working groups in different curriculum areas, involving staff from other schools and students from teacher training institutions.

- "Curriculum map of IT at the school" allows the "whole staff to see what the students' experiences with IT are in other subjects in each of the years, and we are able to ensure that there is not repetition of IT activities between departments."

- Each department has an IT representative, these meet regularly and "ensure the dissemination of information."

Summary: Emphasis on instructional ideas, coordination within the school.

Appendix E

Results, Summary of Section 5 of the Case Studies

In this appendix, we include in the authors' own words, a summary of what seem to be the major points about the results to date of the TES projects, as stated in Section 5 of each of the case studies.

Mount Newton

- Teachers are making significant progress, whether measured on program component or on personal growth (ACOT) indicators.

- "Workshops" are on the way out...Mentorships are on the increase...and the mentors are not always our lead computer in-service teachers. The circle of involvement is widening.

- Teachers' attitudes toward microcomputers and related technologies are positive, with a desire for students to have ready access to computers.

Teachers would like time during inservice to modify and develop activities for their classrooms. 56% felt competent integrating software programs and activities from workshops into teaching; 50% felt they would increase instructional uses of computers with students; 50% expressed a desire to have a workshop leader work directly with them in classrooms; 44% felt that too much information was presented for them to absorb comfortably.

- There is a noticeable shift from personal productivity to classroom applications to curricular integration of computer use. The inservice model relies to a great extent on teacher release time, with teachers following up the inservice with considerable activity on their own time. Also important is the availability of expert mentors, including the lead teachers, for classroom support following in-service.

- The other "hard data" that we have is in the form of learning logs for the action research projects.

  "Was the use of technology helpful in your learning? Why or why not?"

  The teacher answered this with:

  "Yes, students enjoyed the... They demonstrated knowledge of...Students are highly interested and motivated."

  The following answers were given by students...

  "...it helped me learn more."
  "Yes, because it's more exciting than the other ways of learning..."

  "It was because it showed great graphics, faster than a teacher on the chalk board."

  "Yes, it made it easier to learn the information."

  "Yes, because it was more interesting."

  "Yes, technology makes learning fun..."

  "It helped us by showing the whole class a model and the real thing at the same time."

  "Yes..I think it goes quicker and we learn more. It showed us in detail what we were talking about. It is easier to learn."

Monterey

- Administrators and district staff (are) working in a collegial and team atmosphere to achieve.... A school-based planning and decision making process....

- The major instruments for data collection that have been utilized are:

  - Student Impact Report Card
  - Structured Teacher Interviews
  - Inventory of Teacher Reactions
  - Teacher Reflections Reports
  - MMTS Student Survey
  - Visitor Information Survey
  - Individual Portfolio Assessments
  - CIP-specific Data Collection Instruments
  - Standardized Achievement Tests
  - Picture Inventory of Student Reactions

- Findings are numerous; highlights:

  - District and state standardized achievement test scores and writing proficiency test data were analyzed. Spring scores showed relative increase at the secondary level and one elementary site while those at the second elementary site remain approximately at the same level. Writing proficiency increased at all sites. There was a tendency for achievement test scores to increase at MMTS sites.

- Teachers across all schools consistently indicated that their classroom interventions produced a moderate impact on grades of the students in the sample. Elementary teachers rated their classroom interventions between moderate and high while the secondary teachers rated theirs as slightly below moderate.

- Increased teacher commitment, interest, and confidence in the use of technology as a result of CIP specific evaluation plans

- Many CIPs are in varying stages of development ...some are beginning to produce specific findings. Sources include teacher perceptions, observations of student work, analysis of student portfolios of CIP-related work, performance on teacher-made, CIP-specific tests. Some of the findings were: (1) using the word processor caused a reduction in student errors during composition; (2) computers and Instructional Television (ITV) increased enthusiasm for writing; (3) ITV at school increased use of ITV at home; (4) cooperative learning and computers facilitated students learning from each other; (5) student self-confidence increased; (6) results from self-paced experiences increased application of technology, resulting in increased problem-solving abilities; (7) student motivation for writing increased when using the computer; (8) spelling test scores increased; (9) students were found to be motivated by ITV when it supported a thematic approach to instruction; (10) calculators improved student problem-solving abilities; (11) teacher productivity increased due to computers aiding in spell checking and editing for students; (12) student attention span increased as a result of the LCD combined with the computer; (13) students using HyperCard and laserdiscs in science increased their science grades.

- Teachers generally reported that their CIPs increased student achievement and academic performance. However, most CIP-specific data are based on observation and perception.

- Identification and dissemination of promising practices includes: a 4-part video kit highlighting MMTS, an "adoption/adaptation" guide and 13 CIP-specific "products" for packaging for initial dissemination.

- The MMTS Project offers a model for technology use planning and a variety of emerging and replicable projects and practices.

West High School (Ohio)

- Many examples of the transfer of knowledge and skills from the classroom to real world business solutions have occurred. Examples include: scale model building with robotics through interactive video laser disc; database management and spreadsheet designs with custom windows and dialog boxes; and a 4-color 11.5" by 14.5" forty-eight page newspaper publication.

These projects, following the knowledge construction approach, were student-created solutions for Columbus community business leaders.

- (Students in) both of our graduating classes in 1990 and 1991 were offered complete college scholarships to six universities. A total waiver of tuition, room, and board was given in exchange for students accepting the responsibility of serving as technology consultants to the universities. International businesses located in Columbus, Ohio have hired some of the ACOT students as technology consultants and are funding their colleges expenses.

- Much of the program's success is not measured on today's standardized tests. The ACOT students have demonstrated much more knowledge and problem solving ability than standardized tests measure.

- Students accelerated in both quality and quantity of their writing skills compared to control groups. The ACOT students performed as well or better on their mathematics and science tests than non-ACOT students.

- Teachers must be extremely flexible and willing to quickly change lesson plans when working with technology.

- (Based on the experiences at West High School), some modifications made by Columbus Public Schools for its other 18 high schools are:

- Adding Macintosh Writing Centers in all the other Columbus high schools.

- Productivity stations made up of a Macintosh computer and an Apple LaserWriter printer were placed in all the high school journalism departments. This equipment paid for itself with its publishing ability within two years.

- LaserDisc technology has been added to several science departments and social studies department.

Netherlands

- The general observation is that some changes are happening at different levels— the school, the teachers, the curriculum, but only in a very slow fashion.
- Introducing computers does affect the school in many practical ways: there is a constant need for (a) more facilities (hardware, space, time), (b) extra personnel, and (c) released time for teachers.
- The computer coordinator, the computer lab manager, and the system manager are new functions in the school that are absolutely necessary.
- The integration of the administrative activities and administrative automation is growing.
- Teachers constantly claim they need more released time. Lack of time is felt as a constant problem.
- The computer is becoming a normal and regular tool in the classroom for teachers as well as students.
- With respect to the existing subject areas in the schools, there is no clear indication that using computers is changing the content of the curricula. On the contrary, when teachers select courseware, their major criterion is the connection of such a package to the existing learning material, methods and textbooks. Moreover, teachers experience a heavy work load, which prevents them from engaging in time-consuming experiments with the curriculum.
- Using computers to support the teaching of informatics is the most popular application of computers in the DTES project. The second most popular is using computers in the context of learning Dutch, especially to support the writing process and in particular the planning of essays.
- Computers are not changing curricula but are changing some instructional strategies within existing subject areas: (1) the use of computers to record and interpret data collected during experiments in the physics laboratory, (2) the integration of reading and writing instruction and practice in the department of Dutch language, (3) the use of databases in the department of geography has created an opportunity to enable students to reason with raw data, to arrange data into tables, and to analyze co-variance relations between variables, (4) the use of a graphics program to depict and analyze all kinds of algebraic and trigonometric functions in the mathematics department has stimulated students to spend less time on drawing graphs and calculating function characteristics, and more time on problem solving...
- Teachers point at the changing attitude of students toward learning: more problem-oriented, independent, goal-directed.
- There is no indication that teachers in the DTES are changing from being instructors toward being managers of information.
- The use of computers in a school-related context in the DTES raised from 40% in 1987 to 75% in 1989...for instructional purposes from 27% to 53%. Thus teachers are using computers more, even if their roles are not changing because of it.
- The number of teachers that have participated in the PC-privé project (subsidized purchase of a computer for home use) has grown from 22% in 1987 to 70% in 1990.
- The teachers generally consider three didactical functions of the computer as a positive contribution to education: (a) the computer as a monitor of practice and training, providing exercise and immediate informative feedback; (b) the computer as a tool; (c) the computer as a simulator. Three functions are negatively assessed: (a) the computer as a tutor; (b) the computer as a testbank; (c) the computer as a database.
- The teachers feels that working with computers creates new challenges for them and raises their motivation. Using computers also stimulates interdisciplinary approaches between subject-areas. There is broad acceptance of computers in the school, and there is a positive relationship between having a computer at home and having a positive attitude toward using a computer in school.
- Despite all the activities in the DTES project, there is no indication that working with computers is having a positive effect on the academic performance of students.
- Students work very naturally with computers. Students develop a more independent attitude toward learning, show signs of increased motivation, work in a more concentrated and task-oriented manner. Teachers report that students show more initiative while solving problems, more often correct mistakes after immediate feedback, develop a more inquisitive and independent attitude toward learning.

School No. 56

- To experiment with new technologies within the framework of school activities is much more complex than developing educative-instructive activities outside the school program.

- None of these (possible computer-use) activities ...can be rejected beforehand, as pupils enthusiastically involve themselves in all types of activities, and have good results from the point of view of acquired skills.

- The team also noticed positive effects as an outcome of spontaneous contacts between groups of pupils engaged in various computer activities (discussions, exchange of programs).

- In as far as teachers are concerned, experience proved that the idea of new technologies being used in schools is generally accepted but the lack of official obligation to do so leads to a neutral or even a negative response from some of the teachers.

- (Teachers) require permanent training and effective guidance for long periods of time, which means effort and time-consuming activities.

- As for the pupils, they embark on computer activities in a natural way. The novelty of computer technologies, as well as the different modality of study, obviously create a deeper motivation for pupils.

- It can be stated that implementing these technologies in schools altered the atmosphere in the school.

- Collaboration between school and the research field resulted in a valuable experience.

- The most valuable outcome was the building up of a collection of computer assisted activities, which the pupils enthusiastically embarked upon.

Comptown:

- Results were repeatedly verified by classroom observations as well as by teachers and principals (about 40% of Emory's 1988\89 teaching staff) who reported that CBI-induced accommodations dramatically changed their instructional pace, pedagogical techniques, attention to individual students, and students "learning styles."

- ...the computer reshaped the orientation of principals, teachers, and learners. ...(the) effects were inseparable aspects of a growing computer culture; ...by initiatives and effectuations of teachers, school principals, computer coordinators, parents, and key community personalities, all of whom undertook Comptown's responsibilities and systematically continued to develop a supportive ecology for computer based activity in post-Comptown years.

- Centralized educational policies and voluntary activities affected and were affected by the innovation...(they) accelerated intersystemic dependencies and narrowed the gap between the school culture and the already expanding computer culture in the real world. ...frameworks were systematically developed in which, independent of Comptown's activity, new initiatives and new dialogues could be generated in the future.

- ...Realization of...innovative potentials of an "open" computer technology requires modifications in prevailing patterns of instruction.

- Emory's teachers were trained to use computer technologies in a mindful manner (i.e., to understand the inherent educational qualities and apply the technology appropriately), while changing their pattern of instruction...through a four-step training procedure by which (a) teachers were trained to use the technology mindfully; (b) teachers trained students to use the technology mindfully ; (c) teachers trained students to apply the technology appropriately with curricular subject-matters; (d) teachers guided students to apply the technology mindfully with an independent study.

- There were no computer use gains in the word processing studies (results were attributed to Israeli children's typing difficulties), while gains of computerized simulation and data base construction were significant in specific ways: In the simulation studies (conducted with eighth and ninth-graders in two consecutive years) (a) about fifty percent of the "CBI" children handled "multiple inference" problems appropriately, while none of the "control" children could offer even partial solutions, and (b) "CBI" and "control" children performed equally in applications and "one-step" inference tasks. In the database studies conducted with fourth-grade students, the acquired skills were "general" (data organization, identification of meaningful variables, formulation and testing of hypotheses), and the correlations between IQ scores and database (pencil and paper) test scores were lower for "control," and higher for "CBI" children.

Black Middle School:

- Over 70% (of the teachers) have regularly integrated computers into their instruction, using computers in the labs, or classroom, and for personal productivity at the very least once a week and frequently much more than that.

- Teachers used the computers in a variety of instructional settings to improve the quality of education at F. M. Black....over 80% of the student body was involved in computerized math instruction with over 65% of the student body involved in word processing activities and computer assisted language-arts instruction.

- The students learned and had a variety of skills reinforced through use of a variety of stand-alone mathematics software packages ...and also used the spreadsheet...to develop their own solutions to mathematics problems.

- The teachers reported that students have shown significant improvement after participating in computer-based tutorials in language arts and math.

- (In Special Education)...the computer has its own colorful way of reinforcing the child's learning process. It gives the opportunity to participate. To the student it's fun. Students look forward to going to the computer class. They remind us what day is theirs.

- Strong school leadership and comprehensive courseware were noted as key reasons that computers were in such evident use at the time of the original evaluation.

- In essence, teachers were extremely cooperative and receptive to the implementation of the computers at F. M. Black. Another unexpected benefit was that the adjusted scaled score of students taking the required statewide proficiency test improved significantly, backing up the majority of teachers' claims that the use of the computers had a positive effect on their students' achievement.

- By the final phase of the evaluation it was found that the program influenced the instructional climate of the entire school, through the enhancement of staff morale, student morale, and instructional organization.

- As a side benefit, F. M. Black's administrative staff indicated that the use of the computers had greatly enhanced their speed and accuracy in the performance of tasks.

- What was learned from the School of the Future Project, concerning computer training for teachers, software applications, teacher apprehensions and needs, student interests and abilities along with a myriad of other details is now regularly applied to new computer implementations across the district.

Quinte:

- (A) change in attitude of numerous teachers. Most teachers did rise to the challenge of trying to utilize computers. Once they did use the software with their classes they were usually convinced although they still required support for their later excursions to the labs. About one quarter of the staff reached the point where they would use the computers on their own volition, and the use of simulation software was written into their course of study as an integral section.

- This level of use occurred more frequently in geography, math, chemistry, and family studies. Other teachers used the computers simply as an alternate instructional method. Still others tended to use the computers as a method for change of pace. A few used time in the labs as "reward time" for their classes. The more comfortable and committed the teacher was to the use of computers, the more likelihood there was of the curriculum being modified to include specific computer use.

- Continuous ongoing support...was crucial (but)... it is also necessary for support to gradually be removed from a high level to a lower level as it is very unlikely that sufficient resources will be available for an extended period of time.

- We had anticipated a drop off in computer use when the project was over. This did in fact occur (but)... There followed a period of rejuvenation about one year after the end of project that saw the dismantling of one of the cross curricular labs and the moving of those computers into individual classrooms as single computers or in groups of two or three. At the Board level, we began to experience a snowball effect as requests for computer hardware, software, and inservice workshops accelerated. Schools are now using industry-standard word processors and spreadsheets, databases, drawing and paint programs, CD-ROM-based encyclopedia and periodical indexes, external real-time measurement devices attached to computers (e.g., IBM Personal Science Lab), music editing, sequencing, and scoring software. Libraries are converting to a multi-tasking multi-user computer based catalogue and circulation system.

- Many teachers are now self sustaining in computer use. They use the computers on a regular basis and view them in the proper perspective of simply another instructional methodology to be used when only appropriate—meaning when the computers' use is the best way to get a concept across to their students. The teachers view themselves as responsible for their own inservicing and rely less and less on central support. The goal of a good consultant should be to eventually become redundant by raising the level of expertise of clients to the point at which they provide each other with the ever diminishing amounts of support needed.

- Students view computers as a tool. The word processor is used as a matter of course.

- The project was successful because of many significant factors. A computer rich environment was provided. Software was of good quality. There was a well thought out approach to inservicing. Substantial support was available from the beginning and was purposefully withdrawn later to force teachers to take ownership. It is essential that adequate financial resources be available to allow support personnel time release.

  Teachers were asked to document their activities on the computers and write worksheets to be shared in other schools (in fact with the whole province). The worksheets that the teachers developed (are) currently available.

- What the project did to the school was remarkable. Teachers were rejuvenated, students were enthused, administrators were proud. The school became a leader in its educational community. Coordinators were invited to speak around the province and even in other continents. One even wrote a chapter for a book.

Netherhall School:
(Note: As this case study did not describe a project as such, but on-going efforts to create a "technology-enriched environment" within an "ordinary" (non-project) school, we will summarize here only the most current activities in the school:)

- By the summer of 1991 the school has been equipped with 130 computers and 72% of the staff are confident and competent classroom users of information technology in the classroom.

- We have seen a dramatic rise in the number of teachers attending workshops and asking for curriculum support.

- As a result we have been busy collating departmental IT packs that are to be distributed to departments at a forthcoming training day. These packs contain software and hardware catalogues, database files of whole school resources such as hardware distribution, newspaper articles on IT for the last two years, desk top publishing files with outlines for records of achievement and headed notepaper for letters, and so on. The training day will involve a representative from every department in the school, The IT Working Group, and this core of 14 staff will be given an update on curriculum developments, the school's IT curriculum map, IT departmental policy and the future, techniques and methods of assessing IT in their subject, and inservice needs. They will be trained to take responsibility for IT in their subject and to pass it on to others in their department and so increase not only their own professional status but increase the awareness to everybody of their role of promoting IT within the curriculum.

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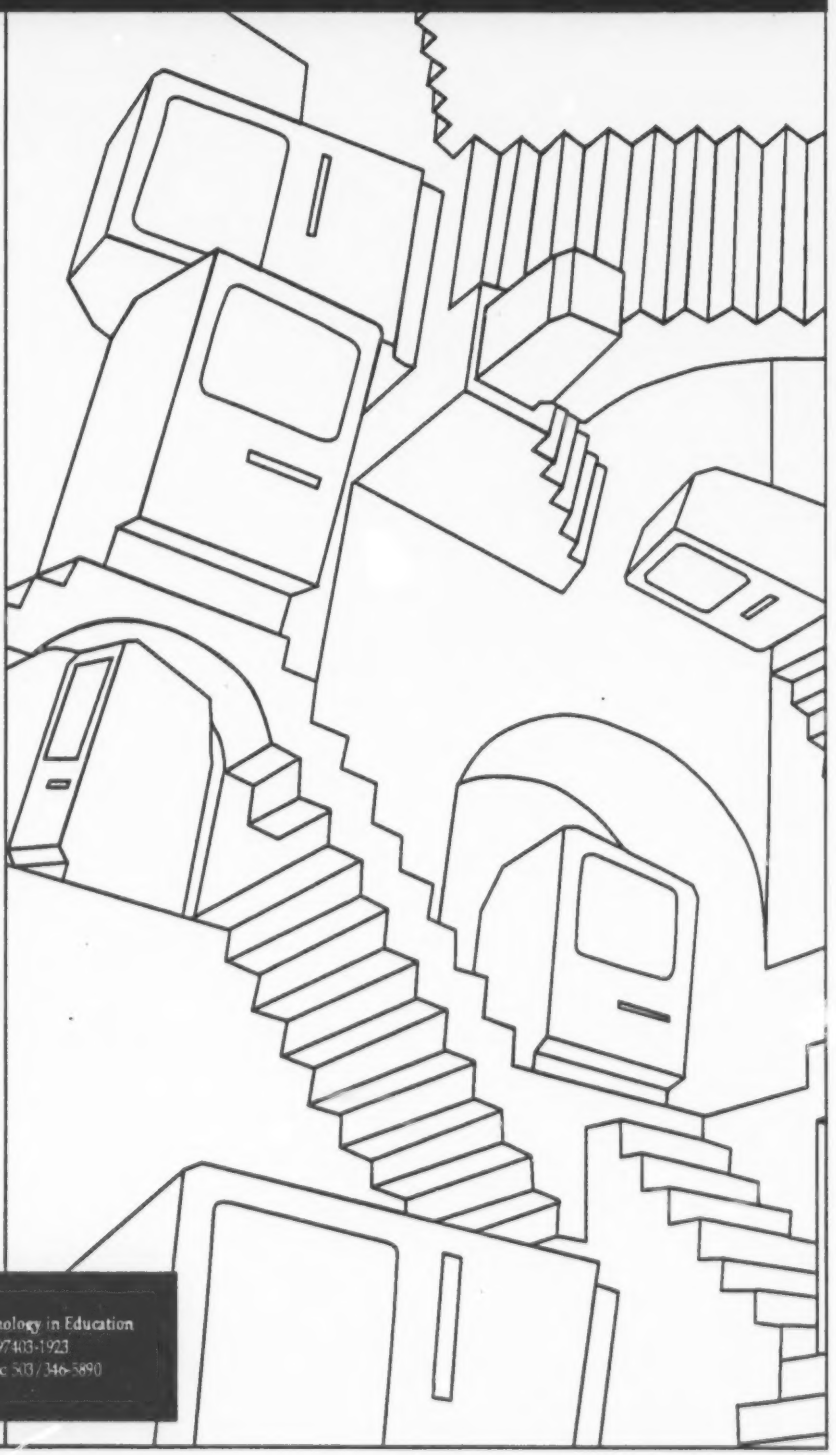

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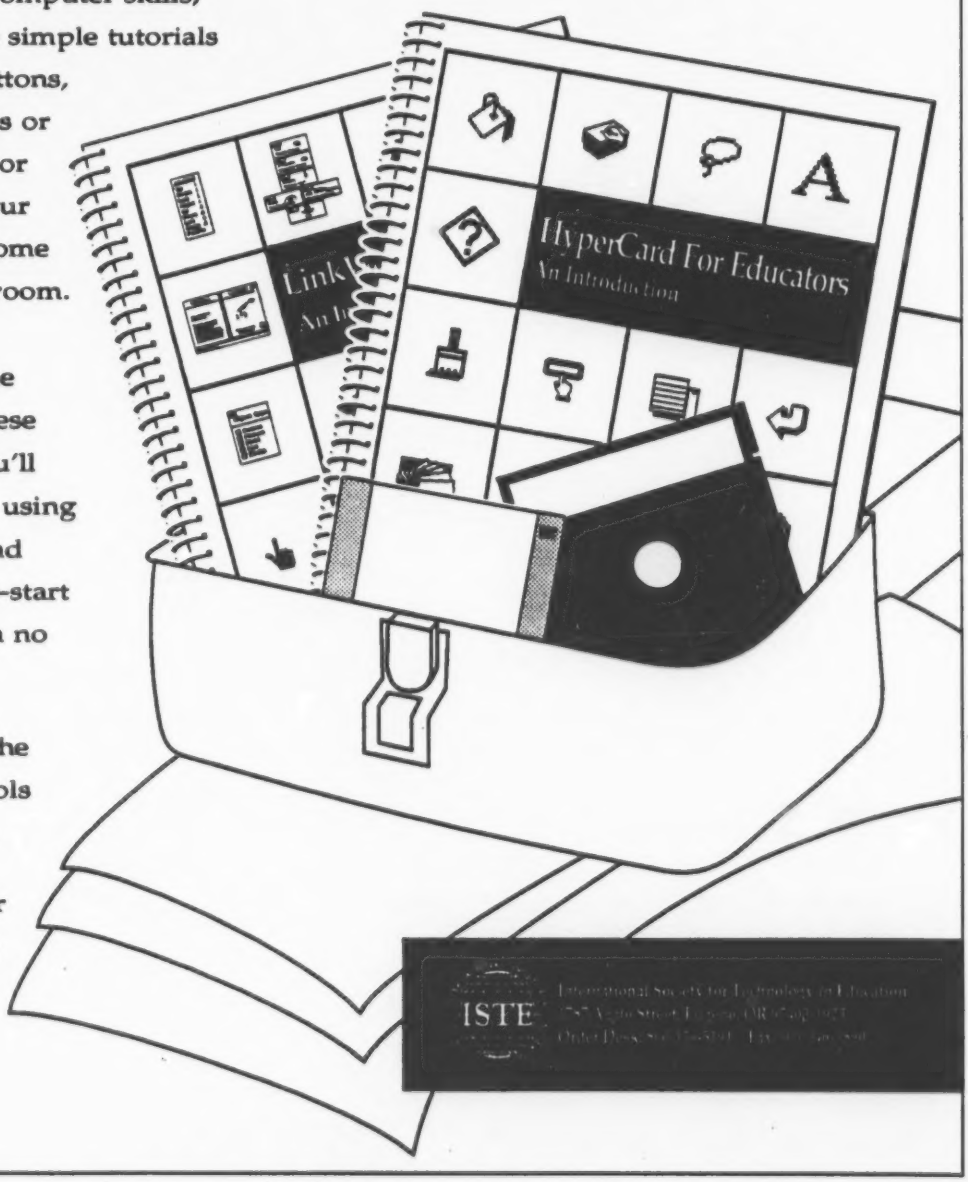

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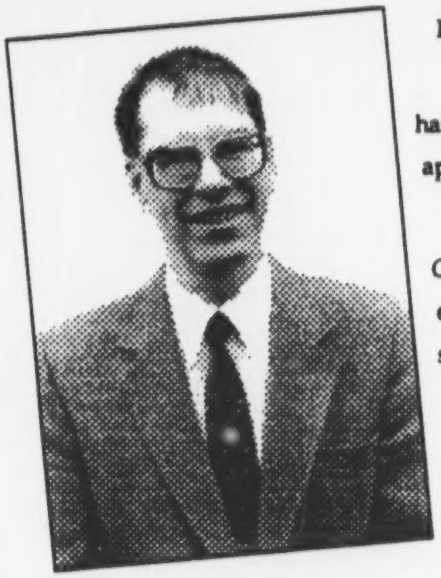

ISTE Executive Officer Dave Moursund is dedicated to improving education.

Since he first began working with computers in education in 1963, Dave has constantly sought to improve education at all levels through the use of appropriate computer-related technology.

As a continuing part of this effort, Dave's newest book—*The Technology Coordinator*—discusses the goals of education and how teachers and teachers of teachers can join in the enormous change process facing today's schools.

This book was written for educators who want to play a leadership role in the instructional use of technology. Dave uses interviews with technology coordinators to illustrate the needs, roles, and qualifications needed to accomplish the goals of educational technology.

In recent years, Dave has focused much of his writing efforts on problem solving and on staff development. Some of Dave's other books also available from ISTE include *Problem-Solving Models for Computer Literacy, LogoWriter for Educators: A Problem Solving Approach, Logo PLUS for Educators: A Problem Solving Approach* (co-authored with Sharon Yoder), and *Effective Inservice for Integrating Computer-as-Tool into the Curriculum.*

"Our educational system is not nearly as good as it could be," says Dave. "We know that computer-related technology can make substantial contributions to improving both the content of the curriculum and the instructional delivery system. Such technology can empower students and teachers."

ISTE believes that computer-related technology must become a tool that students and teachers use routinely if students are to be adequately prepared for adult citizenship in our Information Age society.

ISTE's wide range of periodicals, publications, projects, and other activities mirror this vision and commitment.

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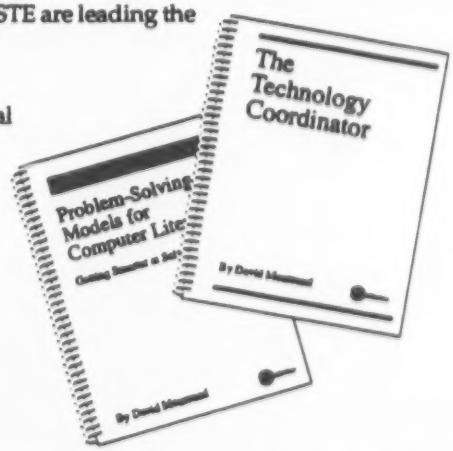

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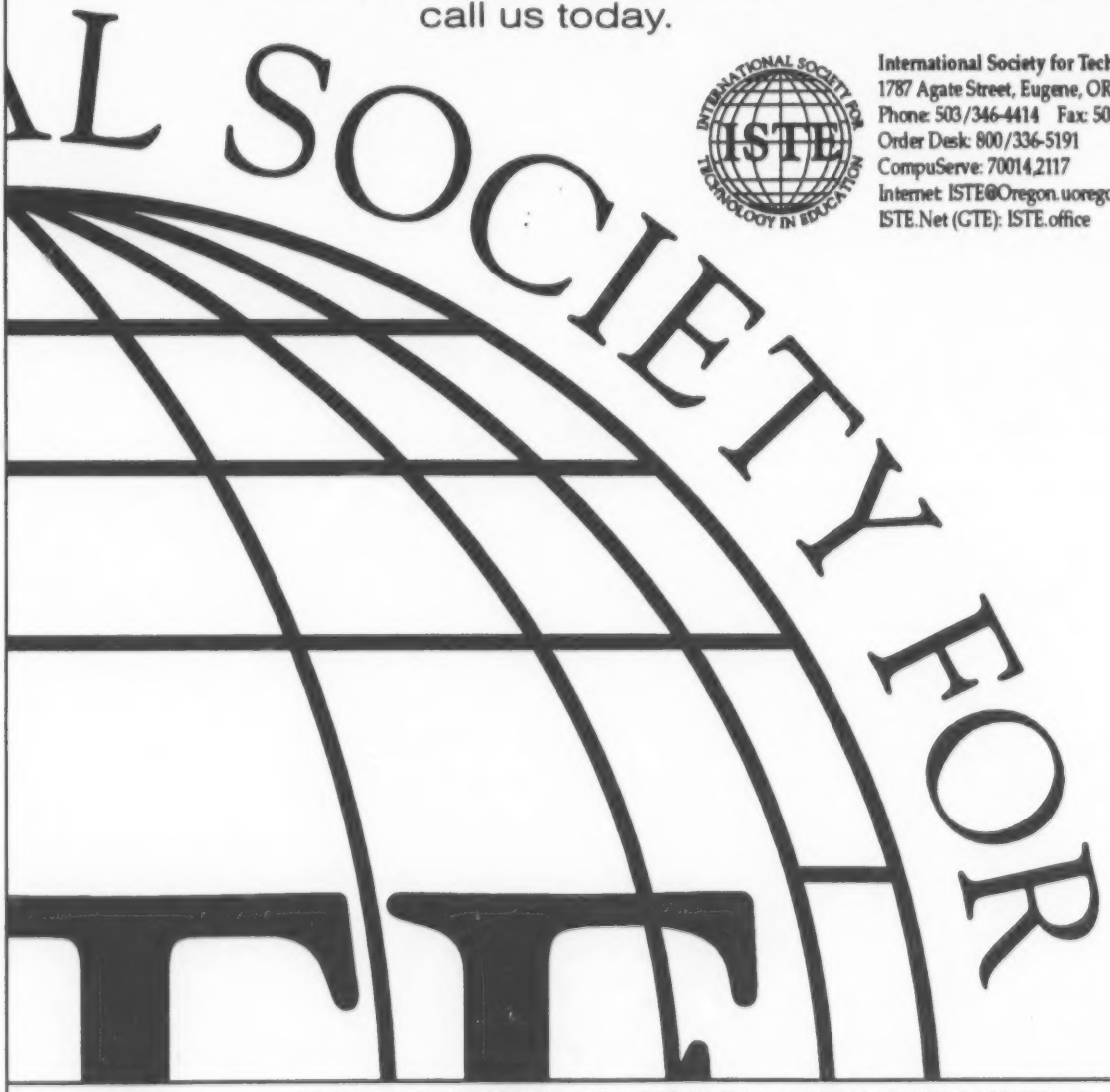

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